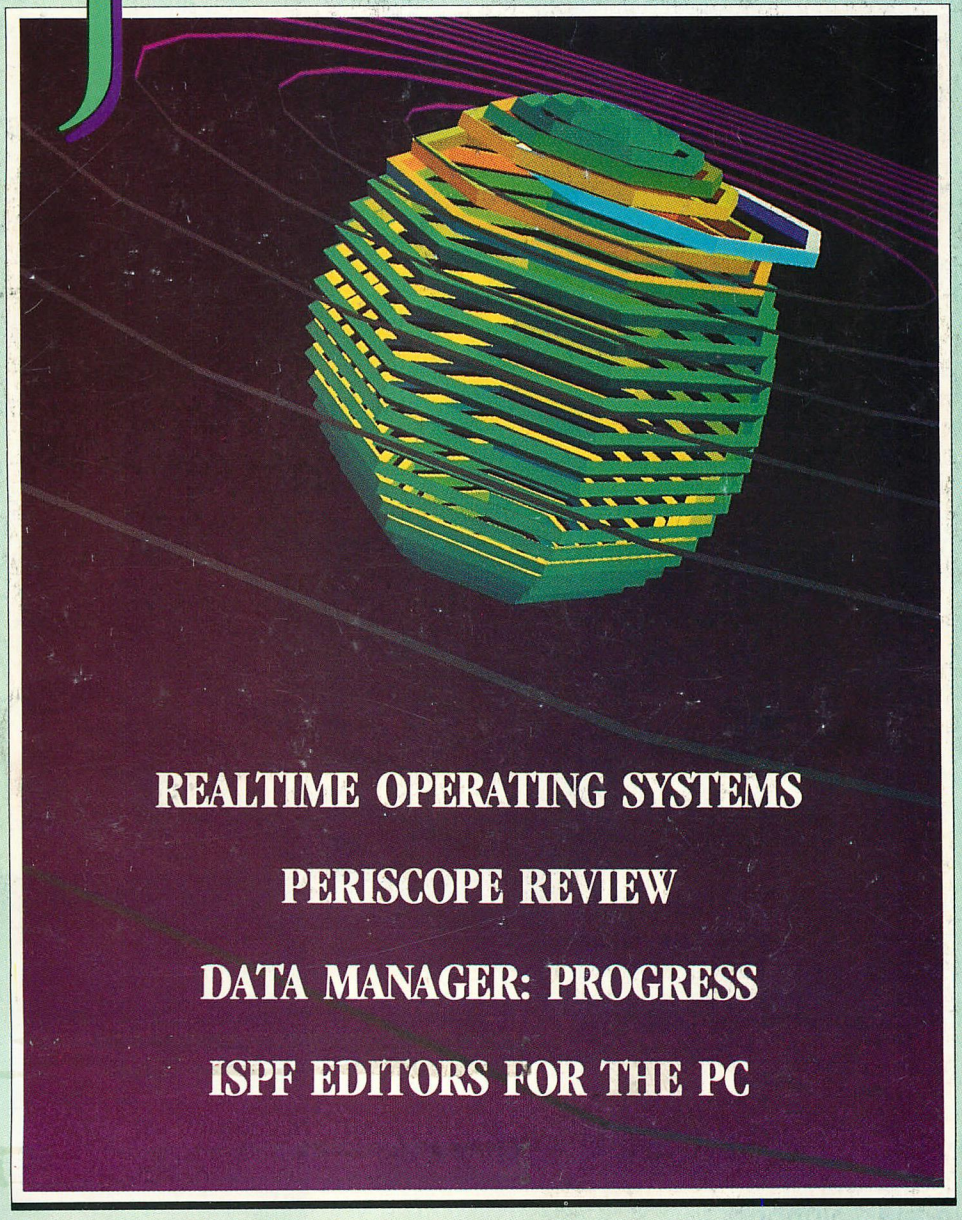
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REALTIME OPERATING SYSTEMS

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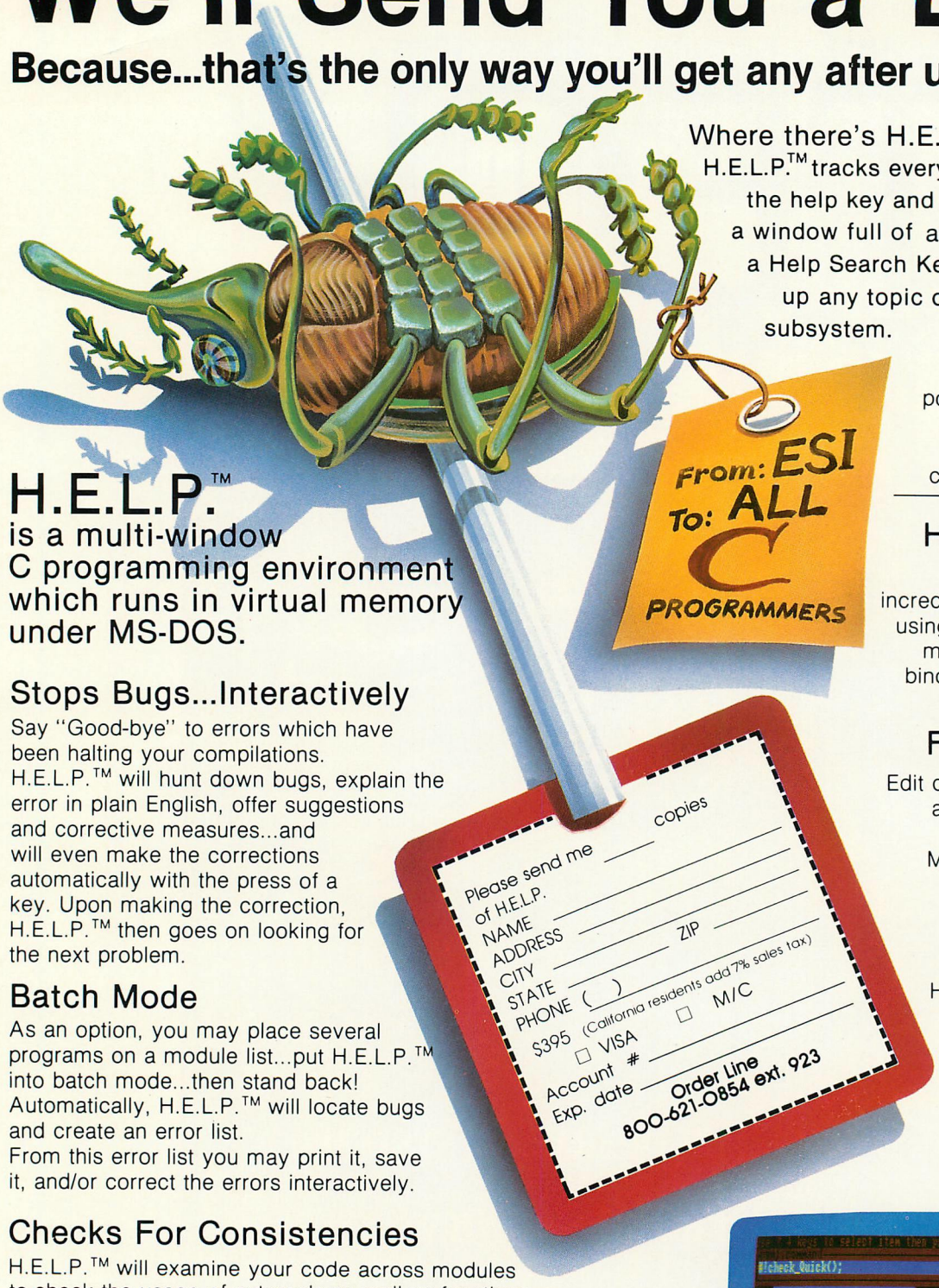
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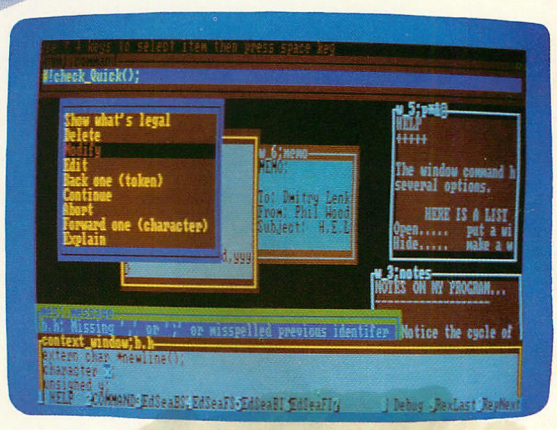
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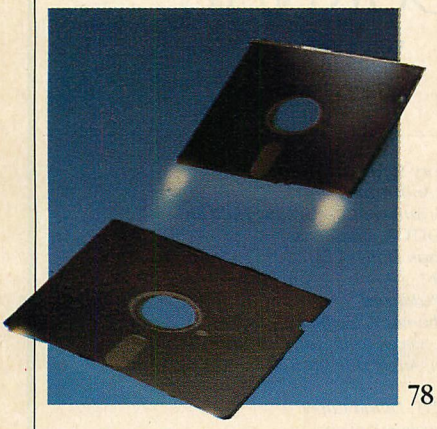
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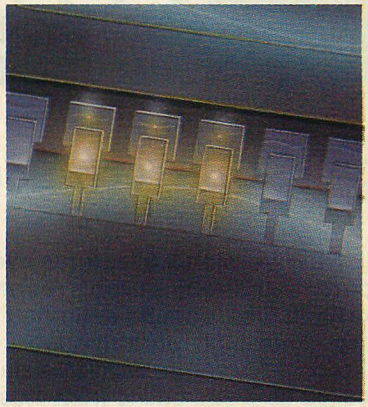
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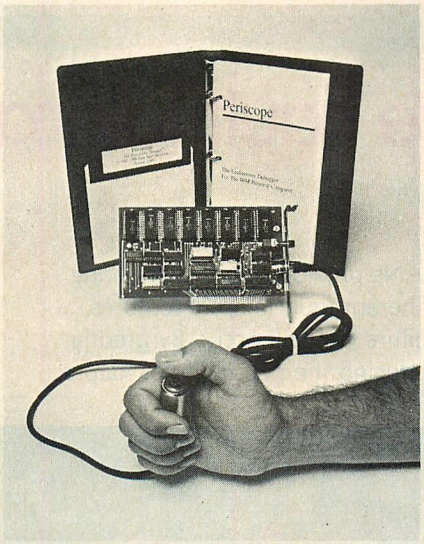
"I can't live without it!! BRIEF, a text editor my company wrote, would not be as stable as it is today without Periscope." —David Nanian

With Periscope's broad range of capabilities, you can thoroughly debug your software, giving it the reliability it needs.

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The break-out switch gives you what one user calls "spontaneity of debugging". Press it anytime to stop the executing program and see what's going on. The switch is so handy you'll want to use it to learn more about your PC!

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BREAK-OUT SWITCH

The break-out switch included with either model of Periscope enables you to debug anytime, even if your system is hung. The Periscope II switch taps into an already-in-use slot, so you don't need a spare slot to install it. The Periscope I switch plugs into the back of the 'Submarine' board, which requires a slot.

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If your program writes to memory below itself, you need Periscope I's protected memory to make sure crucial debugger software isn't overwritten. Other than the protected memory, Periscope I and Periscope II are functionally the same debugger!

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Achieving a LAN Milestone.

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In the development of any product or system, only a select few breakthroughs or advancements in technology are significant enough to qualify as milestones. Novell's introduction of System Fault Tolerant (SFT) NetWare is one of those milestones.

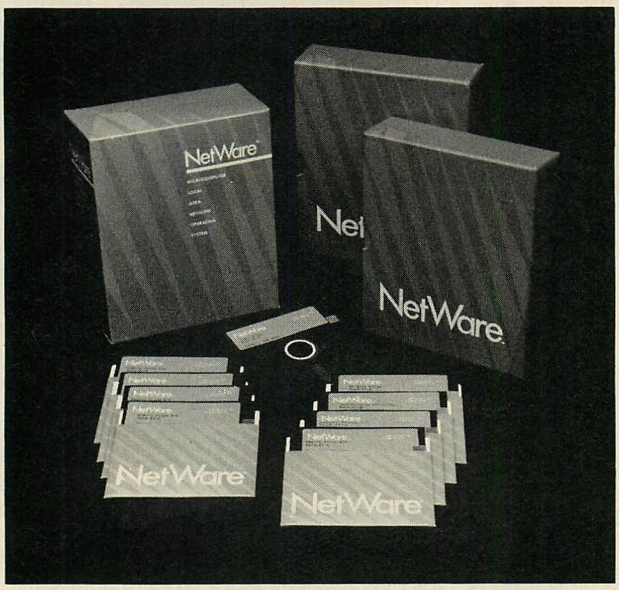
What makes SFT NetWare so significant? After all, other fault tolerant systems preceded the development of SFT NetWare. Even more important, who needs fault tolerance?

Data Disaster

Anyone who cannot afford to lose valuable data stored in a computer system needs fault protection. Whether for more traditional mini and mainframe systems or the office automation newcomer, local area networks, protecting against loss of data is a number one priority.

As the number of LAN systems being used to share information in business and industry continues to rapidly increase, the importance of LAN fault tolerance grows. Because as more and more data is stored and shared in a LAN system, the specter of a major data disaster looms larger and larger. And the need to avert such a disaster becomes critical.

While the distributed processing environment of personal computer LANs provides users with many inherent fault tolerant features, failure can still occur. By greatly reducing the possibility of failure and providing recovery capabilities, SFT NetWare represents a technological leap in fault protection for LANs. The result of that leap is higher system dependability to accompany the high degree of system flexibility and performance already provided by NetWare-supported local area networks.



Affordability

To make fault tolerance affordable for all LAN users, Novell designed SFT NetWare to utilize off-the-shelf components. In addition, the company wrote SFT NetWare to support 25 major LAN hardware systems.

These two important SFT NetWare characteristics effectively reduce the cost of SFT NetWare to a mere fraction of the cost of other fault tolerant systems. Instead of having to pay for a complete, new proprietary system to get fault protection, in most cases LAN users can now simply add fault tolerance capabilities to their existing LAN systems.

And three varying levels of SFT NetWare allow users to tailor their fault tolerant LAN systems to their specific needs and budgets.

SFT NetWare Level I

Level I provides basic directory and data fault prevention for LAN systems at a minimal startup cost. Through several specific functions like redundant directory structures, read-after-write verifications, and error detection and correction, SFT NetWare Level I protects and preserves data in case of disk media failure.

A particularly innovative function of Level I is Hot Fix. If a faulty area of the disk is encountered during the read-after-write verification, it is marked as "bad" and listed in the bad block table. The data is then relocated to a known good area without affecting the normal operation of the workstation and server interchange of information.

SFT NetWare Level II

While the Level I Fault Tolerant System is designed to prevent basic directory and data faults, Level II provides an additional measure of safety through mirroring and duplication of all data. At this level, fault tolerant data storage for the LAN is accomplished either by duplicate storage units on a single controller (mirroring), or by doubled components, including controllers, drives and power supplies (duplexing).

Having duplicate drives, controllers and channels allows "split seeks" to occur on disk reads. The server examines each read request and determines which drive can respond to service the request most quickly. When two or more read requests are presented to the server, they split and occur simultaneously, effectively doubling the system read performance.

SFT NetWare Level III

Level III combines all of the LAN fault tolerant functions of Levels I and II with duplexed file server operation. Two file servers are interconnected using high-speed bus transfer hardware.

If one server fails, the other server automatically takes over network operation. When the failed server is repaired, it resumes its normal network functions. The entire sequence is completed without downtime or loss of data, and is totally transparent to the user and to the application software running on the workstation.

Transaction Tracking System

A major feature of SFT NetWare Levels II and III is the Transaction Tracking System (TTS). TTS ensures that the LAN system views database changes as a single unit of work (a transaction) which will be either wholly completed or wholly backed out.

If a system failure occurs during a transaction, TTS rolls back all database changes made by the transaction, returning the database to its previous point of consistency. Only the failed transaction is lost, leaving the database in its original form (before the transaction was begun).

During normal operation, TTS records periodic "snapshots" of its database files, as well as an audit trail of updates made since the most recent snapshot. In the event of a catastrophic system failure, TTS performs a rollforward recovery, restoring data to the point of the last snapshot, then applying the audit trail to reconstruct remaining files from the archive copies.

"Anyone who cannot afford to lose valuable data stored in a computer system needs fault protection."

With TTS functioning, virtually any real-time application—such as spread sheets, accounting systems, database managers—can be implemented on the LAN system with disaster prevention.

Summary

The impact of SFT NetWare on the future of local area networking is most significant. Just as the file server revolutionized the industry and set a standard of LAN performance, System Fault Tolerant NetWare is setting a new standard of LAN reliability.

With that reliability comes all the functionality of NetWare LAN Operating System software. Advantages like unsurpassed speed, multilevel security, and over 2,000 available applications. Plus DOS 3.1 compatibility, allowing NetWare to run any applications written for the IBM Networks.

And because SFT NetWare runs on 25 major LAN hardware systems and utilizes off-the-shelf components, an affordable system of fault tolerant data protection is available right now for the majority of LAN system users.

Although no LAN system can guarantee against any failure, SFT NetWare makes enormous strides in reducing the possibility of failure. This major milestone in LAN technology means greater safety of LAN system data and improved efficiency in LAN operation, for surprisingly little cost.

For more information, order the SFT NetWare Technical Description by writing or calling:

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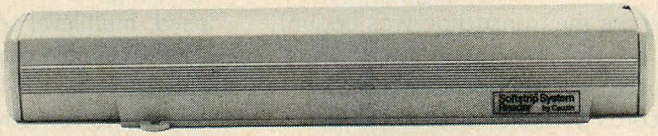
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This new technology allows text, graphics, and data to be encoded on a strip of paper, then easily entered into your computer using a scanning device called the Cauzin Softstrip™ System Reader.



The Cauzin Softstrip System Reader replaces tedious typing by scanning the strip and reading it into your computer.

Creating a simple, reliable and cost efficient way to distribute and retrieve information.

Softstrip data strips, like those you see here, can contain anything that can be put on magnetic disks.

Facts. Figures. Software programs.

Video games. Product demonstrations. Sheet music.



The Cauzin Softstrip System Reader is now compatible with the IBM PC, Apple II and Macintosh.

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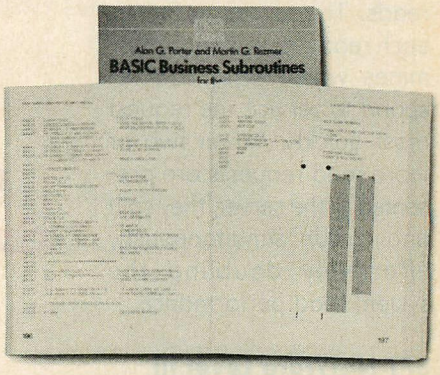
And it can be entered into your computer with a higher degree of reliability than most magnetic media.

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The reader scans the strip, converts it to computer code, and feeds it into any standard communication interface.

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Soon everyone will be stripping as data strips appear in popular magazines, computer books and text books.

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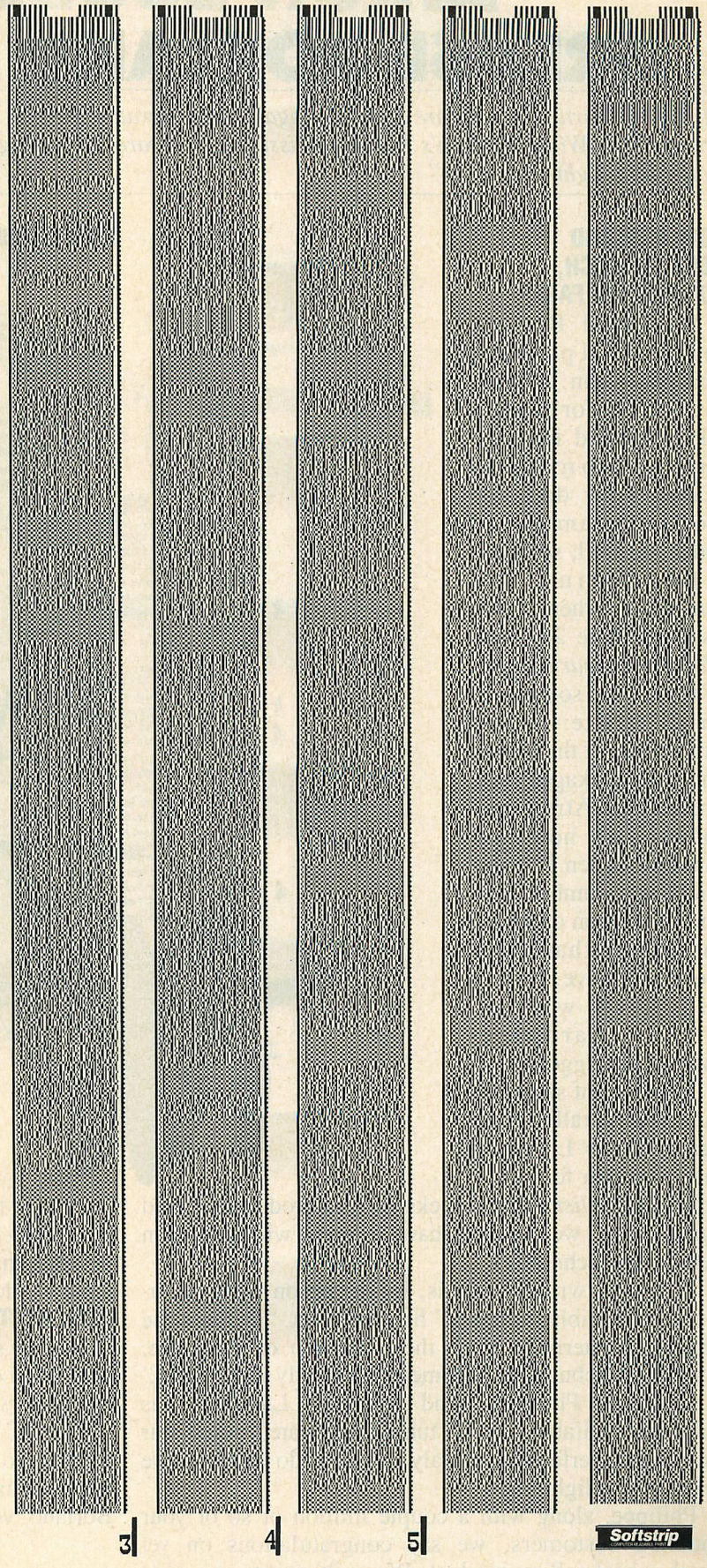
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A DIFFERENT LOOK AT SETS

The Cauzin Softstrip™ data strip allows you to look at data in a whole new light. For instance, the data strips on the right contain the program called SETS which appears on page 108 of PC TECH JOURNAL February 1986. SETS is a utility you can use with Assembly Language to increase the number of features you have at your command. To the Assembly enthusiast, SETS is similar to the Macros Lotus users enjoy. Read the strips into your computer, the files are saved to your data disk. Refer to the article on page 108 in PC TECH JOURNAL, February, 1986 for a complete review and operating instructions.



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ATRON BUGBUSTERS GREASE BORLAND LIGHTNING

"If I were starting a software company again, from scratch, Atron's AT PROBE™ would be among my very first investments. Without Atron's hardware-assisted, software debugging technology, the flash of Turbo Lightning™ would be a light-year away."
Philippe Kahn, President, Borland

HOW BORLAND DOES SO MUCH, SO WELL, SO FAST

We asked Borland International president Philippe Kahn to share his secrets for rapidly taking a good idea and turning it into rock-solid reality. How does the Borland team do so much, so well, so fast?

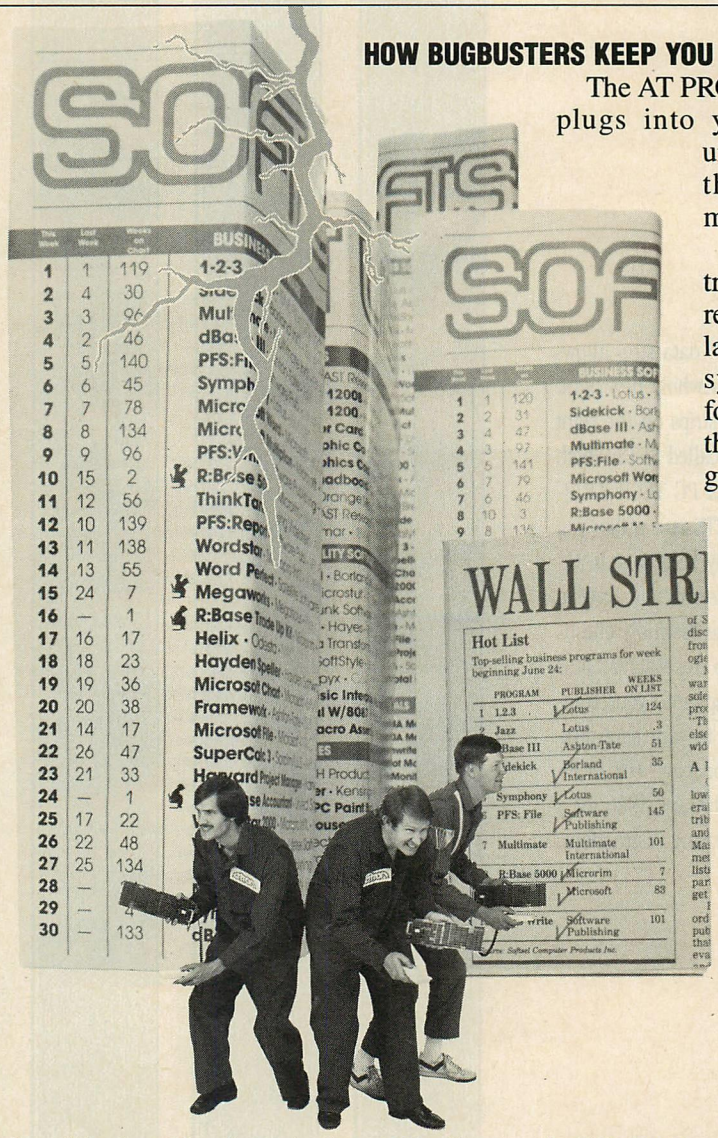
He begins, "I remember when Atron used the June 24, 1985 *Wall Street Journal* chart of top-selling software in an ad." [Note: At that time, seven of the top ten software packages were created by Atron customers; it's now now nine out of ten.] "SideKick was number four, and I let Atron quote me in saying that there wouldn't have been a SideKick without Atron's hardware-assisted debuggers.

"You might say lightning has literally struck again. Turbo Lightning made number four on *SoftSel's Hotlist* within weeks of its introduction! And again, I say we couldn't have done it without Atron debugging technology.

"Cleverly written code is, by definition tight, recursive, and terribly complex," he continues. "Without the ability to externally track the execution of this code, competent debugging becomes very nearly impossible."

Concludes Philippe, "And after Turbo Lightning was solid and reliable, Atron tuning software turned our Probes into performance analyzers. How do you think we *greased* our lightning?"

Philippe, along with a couple million or so of your satisfied customers, we say congratulations on yet another best-selling product. We can't wait to see what awesomely useful technology will come shooting out of Borland International next.



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The AT PROBE is a circuit board that plugs into your PC/AT. It has an umbilical which plugs into the 80287 socket and monitors all 80286 activity.

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It can solve *spooky* debugging problems. Like finding where your program overwrites memory or I/O - impossible with software debuggers.

You can even do source-level debugging in your favorite language, like C, Pascal or assembler. And after your application is debugged, the AT PROBE's performance measurement software can isolate performance bottlenecks.

Finally, the AT PROBE has its own 1-MByte of memory. Hidden and write-protected. How else could you develop that really large program, where the symbol table would otherwise take up most of memory.

LOOK AT IT THIS WAY.

History shows that non-Atron customers don't stand a very good chance of making the Top Ten list. Lightning *really does* have a way of striking twice!

The PC PROBE™ is $1595 and the AT PROBE is $2495. So call Atron today. You can be busting some really scarey bugs tomorrow. And maybe, just like Borland, you can also bust some records.

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THE DEBUGGER COMPANY
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Automatic PCs

IBM's commitment to automated production facilities continues.

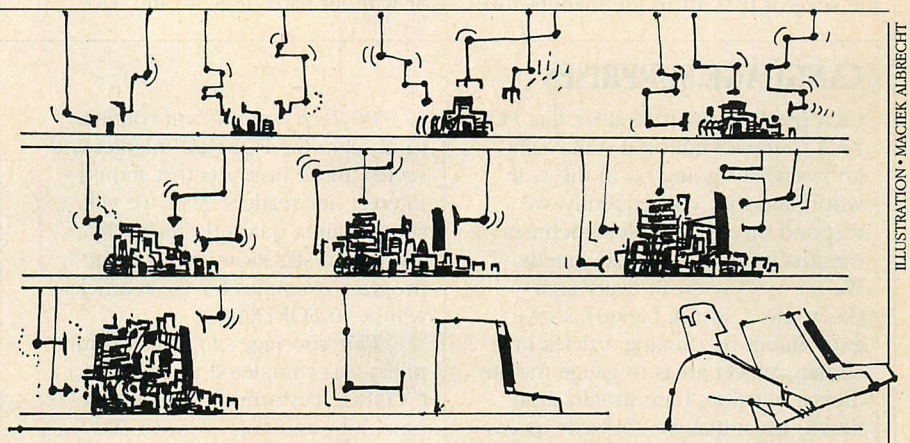


ILLUSTRATION • MACIEK ALBRECHT

I am a real sucker for manufacturing plant tours, a fact IBM must have on file about me. During *PC Tech Journal's* most recent trip to IBM's Boca Raton facilities, Executive Editor Julie Anderson and I visited a production line that was building PCs and XTs, a visit that proved interesting on several fronts.

Most important was the high level of automation on the assembly line; it is the highest I have seen at IBM to date, more so than the original AT line, which was the most automated at the time of its inception. IBM is quite proud of it, too. Larry Hunsaker, PC manufacturing project manager and our tour guide, beamed as he showed us from one end to the other—as well he should: it was impressive.

Before describing the assembly line itself, I would like to share some of my observations of what was *on* the line. On the day of our visit IBM was building five-slot PC and eight-slot XT system units. Most of those PCs had one (!) or two diskette drives; some had *no disk at all*. Hunsaker shrugged at my surprise that diskless PCs were being assembled, saying that he builds what the order says to build. IBM's volume for such systems is probably small; the manual labor content for no-disk PCs is higher because IBM has not automated its cassette-port diagnostics procedure.

PCs with disks are automatically transported on a conveyer system from the start of the line (the "kitting" operation) to the end (boxes on a pallet). Kitting consists of collecting the required components onto a tray upon which the computer travels until it is placed in the box. Thereafter, it is handled by people only for assembly, which consists of mounting the system board, inserting and fastening disk drives, fastening the power supply, connecting wires, and putting on the cover. A visual check is made for telltale mars or dirt.

Once the system unit is assembled (except for cover), it travels through a series of tests. The first is quick, just enough to verify that the machine is alive and to prevent dead units from entering the next stage of testing, a three-hour burn-in. Following the burn-in, a final quick test is conducted. Systems failing any of these automatic tests are routed to manual stations for check-out and repair; as soon as a technician has made the unit operational, it is conveyed backwards on the line to reenter the testing phase.

After the machine is assembled, tested, and covered, it is ready for packing and shipping. On my previous visits this process had seemed very people-intensive, despite the machines IBM used to reduce heavy work. (Packers even use a device to lift the computer off the tray, hold it while a bag is put on it, and drop it into the box.) At great expense, IBM has completely automated this last stage of manufacture.

From the assembly area, machines are conveyed to a sorting area. Each one is tagged with bar code; each tray is also tagged. Using these aids, the line sorts machines into groups of 12, the number of boxes IBM places on one shipping pallet. When 12 of a single type are collected, they are released as a group to the final stage, wrapping and packing. The sorting area is needed because the single assembly line can be producing several different models of PCs and XTs at the same time. The order in which machines arrive for packing is therefore unpredictable and must be accounted for.

The wrapping operation is interesting. A final, mechanical inspection is performed to be sure the assembly is complete. Units missing a part in this last inspection are rejected, but IBM obviously does not expect this to happen because the rejection area can hold two trays at most. Machines then remove the system from the tray, wrap it with plastic (a little magic here: how do you hold something, yet wrap it all the way around?), and insert it in a box. Boxes are simultaneously being fabricated and loaded with bottom packing material, arriving just in time to receive their contents. Top foam is put in place, books and warranty information are inserted, and the box is closed and taped.

Labeling the box used to be a manual process. On this line, however, the bar code of the machine is scanned just before it is placed in the box and the information is then used to operate two large ink-jet printers that directly label both sides of the box. At the end of the line, the completed boxes are stacked on a pallet, which is then wrapped with a strong plastic film. Finally, a human being arrives with a forklift to remove

the pallet from the line and transport it to the shipping area.

IBM will not comment on production quantities. Noting that burn-in seemed to be the critical path, I calculated that a single shift working a five-day week could produce about 700,000 units per year.

Why this long description of IBM manufacturing? This particular manufacturing line could be used to build any IBM computer with roughly the same form/factors of the PC, such as the AT or some new model. It also represents the state of IBM art in the manufacture of desktop computer systems; that state is highly automated and cost-effective, showing IBM's commitment to its reputation for advanced manufacturing techniques. Finally, greater efficiencies in manufacturing enable IBM to maintain higher margins while reducing prices.

IBM may have wished to communicate some messages to us without actually saying anything. One such message may have been that basic PCs, even diskless ones, are still in demand. It is interesting that PCs are still being made at all; I thought by now that XTs, with or without hard disks, would have become the standard. However, the line was not operating at anywhere near its full capacity on the day of our visit. The end of the line, obviously very new, was out of service for adjustment; the packing operation had fallen back to semi-automatic operation. The possibility that the line was being tuned for a new model certainly crossed my mind.

Whatever the hidden messages, IBM can only be complimented for its beautiful, sparkling clean facility and efficient production. It is not exactly necessary to build our confidence; after all, this is IBM. Still, it is nice to see.

LANGUAGE SURPRISES

I am predisposed to believe that *PC Tech Journal's* editorial staff really knows what's going on in the real world and that, consequently, we respond directly (albeit sometimes eventually) to our readers' needs. We are not expert in every area (keep this a secret, please), so we experiment by running articles in certain subject areas to gauge the audience reaction. I am usually gratified to learn that we correctly assess the interest in the subjects we publish. But we do get an occasional surprise; recently we got three.

In this month's Letters column you will find numerous responses to Alan Howard's review of FORTRAN compilers ("FORTRAN Options," October 1985, p. 149). The volume of comment on our coverage indicates a considerably larger interest in FORTRAN than we expected. That led us to conversations with more people in this segment of our audience and the industry that serves it, confirming that FORTRAN is alive and well. Microsoft says that its FORTRAN products continue to do well, and other vendors (more than you might expect) are healthy, too.

One particularly surprising comment is about FORTRAN's portability. Because it is not a systems programming language, programmers are apparently not as likely to exploit extensions supplied by a particular vendor, opting instead for a more standard approach. This portability extends beyond the desktop to the minicomputers and mainframes crunching FORTRAN. We were interested to learn that some programmers prototype FORTRAN programs on the PC that they later will execute for effect on a Cray.

PC Tech Journal will continue to observe the FORTRAN market and review those products that should interest our readers. Also, we will soon begin a quarterly series of articles on statistical methods; the program examples for these articles will be in FORTRAN.

Our coverage of COBOL compilers was completed in August ("COBOL Performs," Ted Mirecki, June, July, and August 1985). We have been following COBOL closely and are not surprised at its strength in the desktop marketplace. The advent of faster computers, such as the AT, and bigger and faster mass storage devices ensures that significant applications will be mounted on desktops. This will be especially true in corporate MIS departments as monolithic COBOL applications are decentralized.

We are also not surprised at the acceptance *PC Tech Journal* has received in the corporate sector, because MIS departments are part of our target audience and a market to which we actively aim. But we are surprised at the *rate* of growth in that segment of our audience. Our 1984 subscriber research study showed that 31 percent of our subscribers worked in corporate MIS departments; the number for the 1985 survey is 40 percent, a 29 percent increase. This evidences an increased need for technical and systems information at the MIS level and a corresponding rise in the number and complexity of the PC projects undertaken there. The assumption that COBOL will play a vital role is not unreasonable.

One of our correspondents (in a letter to be published in our April 1986 issue) complains "...one more article on COBOL compilers and I'll drop my subscription." Well, I dearly hate to lose subscribers, so I'm glad this letter arrived *after* our series of reviews was complete, but the future probably holds more COBOL in store. I just hope the rest of *PC Tech Journal*, in fact, the bulk of it, keeps our correspondent from carrying through with his diabolical threat.

Finally, we got a ton of mail about our coverage of CHASM ("PASM, TASM, and CHASM," Ted Mirecki, December 1985, p. 161). I was quite surprised to see how widespread this user-supported product was. A sampling of the letters will be published in next month's issue, but a general theme rang through. The letter writers called our review of CHASM "unfair" and objected to our description of it as a "toy" compiler. They argued quite persuasively that CHASM had its place and that not everyone writes large assembly programs or needs a full-blown product to handle little routines.

Perhaps we were harsher on CHASM than we should have been. This is not to say we consider our presentation flawed; indeed, the article is factual and complete. Our error may lie in not having a better perspective of how CHASM actually was being used and thus overlooking its advantages for those situations. As usual, we appreciate your feedback and your careful attention to our material.

In each of these three cases we were surprised by the high level of interest displayed by our audience. Thanks for keeping us alert.

—*WF*

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Reviewers at BYTE, INFOWORLD, DATA BASED ADVISOR, and DR. DOBB'S JOURNAL all came to the same conclusion - BRIEF IS BEST!

Further, of 20 top industry experts who were given BRIEF to test, 15 were so impressed they scrapped their existing editors!

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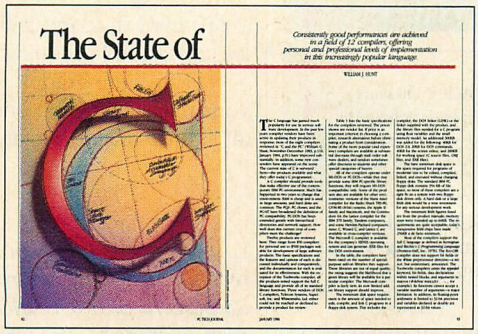
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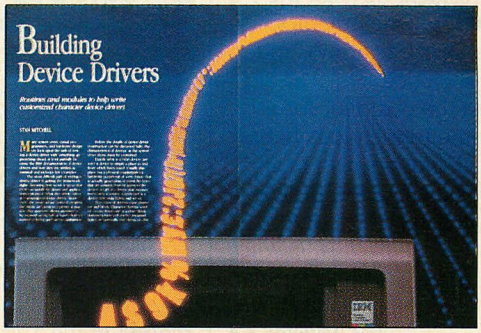
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WILLIAM J. HUNT


Building Device Drivers

Realtime and modules to help write customized character device drivers

STAN MITCHELL

.COM SUPPORTED HERE?

In January's "The State of C" article (William J. Hunt, p. 82), table 1 refers to the Microsoft C compiler allowing a .COM memory module. I called Microsoft to find out what I missed in the documentation that supports creating .COM files from C source code, and was told it was not a feature of this compiler. Do you refer to just memory module size, or is there a way to get the compiler to create .EXE files that can be converted to .COM files?

Jerry Dellasala
New York, NY

Thanks for the correction. The Microsoft C compiler does not support .COM files.
—DB

A GRAPHIC RESOLUTION

Upon reading the letter from John M. Scott Bryan, Ph.D., in the October issue of *PC Tech Journal* (Letters, p. 15), I have realized that there is a lot of confusion among owners of the Professional Graphics Controller (PGC) and I hope that my letter will help to clarify some of these misunderstandings.

When I received my PC/AT with the PGC, I could not wait to try it with my PC-PLOT terminal emulation program, which claims support for PGC, and see the superb graphics on the screen. I did not have to wait long: as soon as I started the PC-PLOT program, I experienced problems similar to those of Mr. Bryan. When I selected communications speed above 1200 baud, PGC was consistently losing characters. After swapping PGC with EGA, I learned that this problem was related to the presence of PGC in my PC.

At this point, I decided to call IBM. Fortunately for me and now for Mr. Bryan and others, I was more successful. The IBM representative with whom I spoke was very knowledgeable and supportive. He told me that all PGCs with serial numbers 6323697 to 6448811 had the described problem and the IBM was now able to correct it.

I found that my PGC had serial number 6323698. I sent it to the IBM service center and the problem was fixed within a few days. Today I can communicate with our mainframes at 9600 baud without losing characters.

Two things bother me. First, PC-PLOT supports PGC only in the mode emulating CGA, so as yet I have no high-resolution graphics. Second, I wonder how Mr. Bryan and you (I assume that you agree by not commenting his letter) could think that PGC was losing characters due to the slow performance in text mode if the problem occurred only when the communication port was used and not during tasks like listing files on the screen.

Frank Klatil
Rutgers University
Piscataway, NJ

Mr. Bryan's letter was checked to the extent that we verified that the problem existed. We then published the letter as a way of informing our readers of the problem. We appreciate your further clarification, especially your report of success in dealing with IBM.
—WF

DRIVING AWAY BUGS

I would like to add several observations to Stan Mitchell's "Building Device Drivers" (May 1985, p.76). Recently I wrote a device driver for an IEEE488 parallel general purpose interface bus.

Although these drivers are difficult to debug, several tools are available to the programmer. The first strategy is to post the device drivers location in the user software interrupt vector (60 to 67H) at initialization time. This will allow the debugger to find the driver in the maze of the DOS driver pool.

The second strategy involves postponing the execution of the initialization code until the first call to the device driver. The programmer using this technique should code the real initialization routine to simply point to the end of the driver routine and set the interrupt vector as noted above.

With the interrupt vector pointing to the device driver, the user can now find the device driver and, more importantly, use the debugger to set breakpoints within the driver. Care must be taken, however, not to trace execution too far outside the module's boundaries because DOS is not reentrant.

John T. Cockerham, M.D.
The Children's Hospital
Boston, MA

Dr. Cockerham offers some good suggestions for debugging device drivers. These are methods that the novice will find useful and that the experienced programmer should keep in mind when all else fails in cracking a tough bug.
—Stan Mitchell

A BASIC DISAGREEMENT

It's about time someone brought to your attention the advantages of BASICA and the new IBM BASIC Compiler 2.0.

Many references have been made by readers and by your columnists about the greatness of C and Pascal and how poor BASICA is with regard to implementation and speed. C and Pascal are fine languages, but the 2.0 version of the BASIC compiler, plus maybe one or two callable machine language routines, can put those languages to shame.

Every conceivable routine can be implemented and all 640KB in a PC can be used by this improved BASIC. Plus, the speed of execution on a PC with an 8088 is acceptable while on an 8088-2, 8086, or 80286 machine it is impressive.

A programmer does not have to worry about what variable is what and can add new ideas as he thinks of them without much regard to starting over each time. The BASIC Compiler 2.0 allows a programmer to make the appli-

cation memory resident through the SHELL statement, plus fine graphics, communications, dynamic arrays, and submodules are included.

I've only had the compiler for a month, but with the tremendous help from the technical support people at IBM, I have become an expert on the use of the compiler in a short time.

I. N. Botnick
President
T.B.S.P., Inc.
Los Angeles, CA

In forthcoming issues, PC Tech Journal *will be reviewing many current BASIC compilers and interpreters.*

—JD

THE CORRECT TEST

The September issue had an interesting article by Cole Brecheen ("Improving Turbo's I/O," p. 104). I downloaded the files to use several of the procedures. One procedure (which is listed in ANSISTUF.INC) named SCRNSAVE has a bug. When I tried to use it, I got the "Too little memory to save screen" message despite my 640KB of RAM.

Maxavail will return a negative number if enough memory is available so it must be tested for sign as described in the Turbo Pascal manual. (Figure 1 shows the correct test, in which avail_paragraphs is a real.)

FIGURE 1: *SCRNSAVE*

```
If maxavail < 0 then
  avail_paragraphs := 65536.0 + maxavail;
        else avail_paragraphs:=maxavail;
if avail_paragraphs * 16.0 < 1.0 * size then
  abort( 'Too little memory to save screen.' );
```

This code modifies SCRNSAVE (in ANSISTUF.INC for "Improving Turbo's I/O") to test for adequate memory.

Ben L. Ettelson
Walnut Creek, CA

Mr. Ettelson makes a good point. Procedure SCRNSAVE has been modified on PCTECHline and now includes all of the corrections shown above.

—Cole Brecheen

HARD TIMES

It seems that every time you review software that I am interested in, the benchmark times are for a floppy disk. I think this is inadequate. Hard disks are available for $400 or less. How many of your readers have hard disks? Have you ever tried doing software development without one? An IBM PC/XT with a 10MB hard disk and 256KB RAM should be considered the minimum.

(I find the graphic arts format of your magazine to be one of the best of all similar magazines on the market.)

Paul Mann
Tustin, CA

You are correct, to a point. Our most recent subscriber research indicates that 85 percent of our readers' companies own hard disks. The percentage is about 60 percent for personally owned systems. Therefore, the need remains for information on floppy disks.

However, we recognize the trend toward inexpensive hard disks. Our feature articles on data management, for example, ignore floppy disks entirely; the benchmarks for those products are performed on an AT. We avoid the XT because so many have been sold with non-IBM drives (the performance of which varies wildly). The AT, at least, has a published specification for minimal performance.

—WF

Thanks for the words of encouragement about our magazine's design.

—IS

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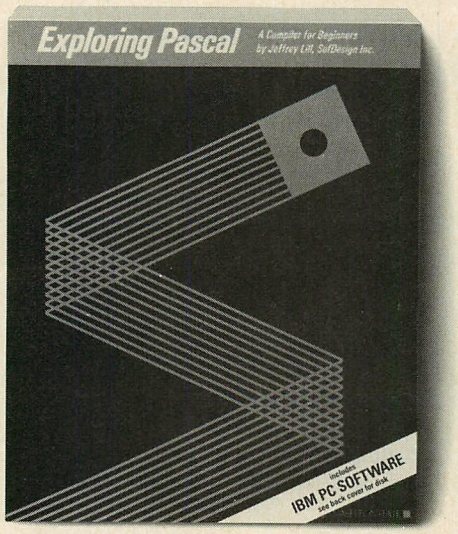
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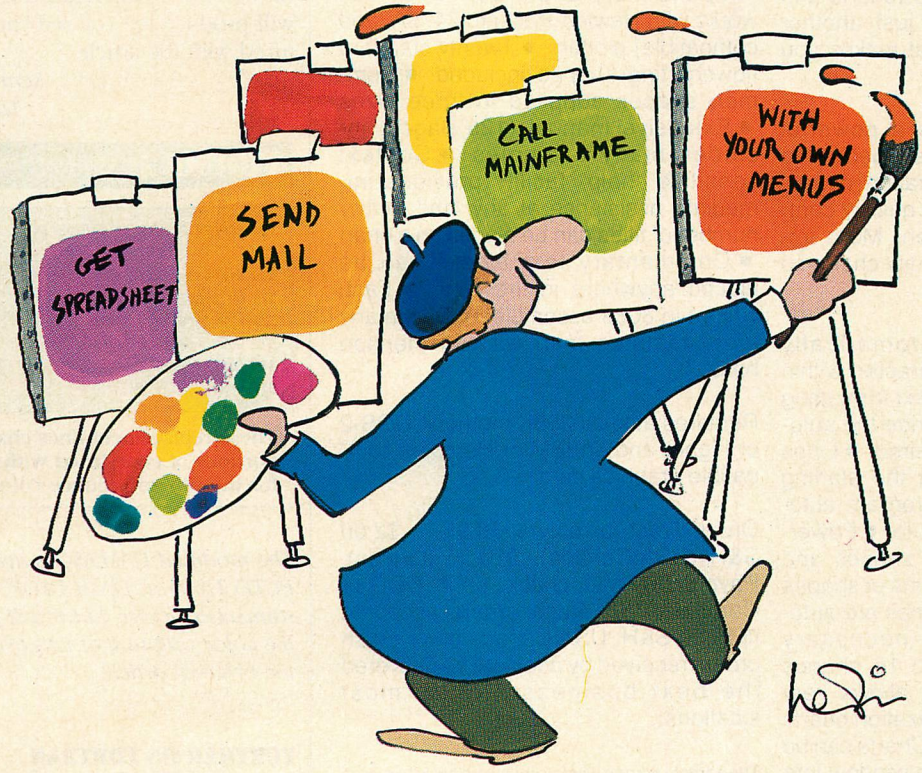
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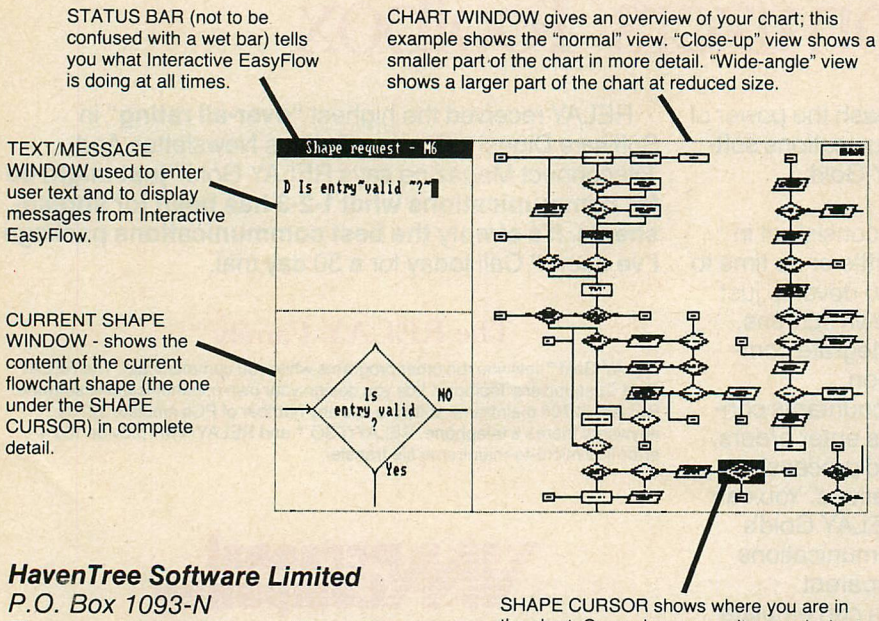
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LETTERS

CURVES IN COLOR

Upon reading "Fractals for the PC" (Eui In Lee, November 1985, p. 165), I was surprised to find that the program listing produced monochrome curves, not the color ones shown. However, by changing lines 50 and 370 and adding lines 371-375 (see figure 2), DAM.ASC will produce the colored curves as pictured with the article.

Kenneth J. Kahn
Lawrence, NY

FIGURE 2: *Revised DAM.ASC*

```
50  SCREEN 1,0:COLOR 0,0:DEFINT I-R

370 N=N+1:S=S+1:IF S>3 THEN S=1
371 ON S GOTO 372,373,374
372 LINE -(X,Y),1: GOTO 375
373 LINE -(X,Y),2: GOTO 375
374 LINE -(X,Y),3
375 NEXT J
```

These replacement lines change portions of code listed with "Fractals for the PC" to produce color curves.

The modified DAM.ASC is available on PCTECHline as DAMCOLOR.ASC. It plots somewhat slower, but it will produce the color output that was printed with the original article.

—JD

FURTHER ON FORTRAN

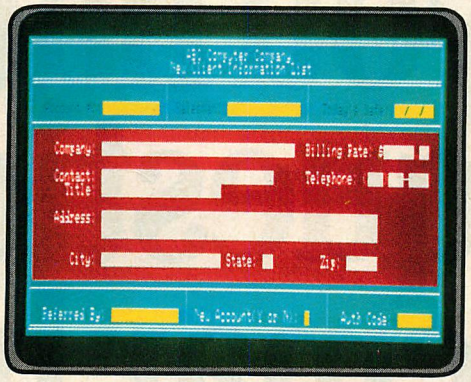
Thanks for the fine FORTRAN article in the October issue of *PC Tech Journal* ("FORTRAN Options," Alan Howard, p. 149). For a variety of reasons, FORTRAN continues to be the language of choice for many number-crunching programs, even on microcomputers.

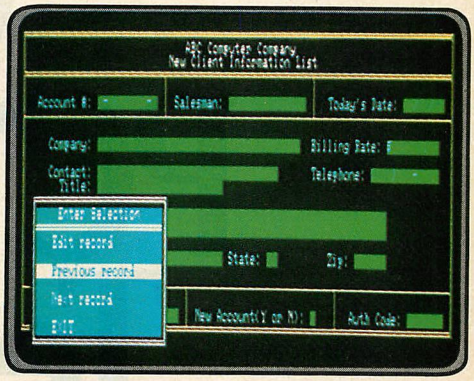
Because I use FORTRAN with relatively large programs, I was somewhat disappointed that the benchmarks and discussions of the compilers did not deal with the problems encountered with larger programs. In particular, I have compared IBM Professional FORTRAN 1.0 with Microsoft FORTRAN 3.3 and came to a conclusion totally opposite to Mr. Howard.

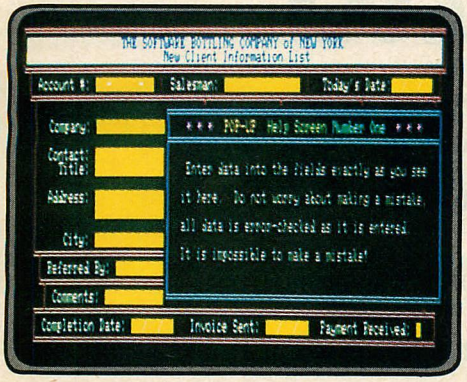
I ran a benchmark on a simple Cholesky decomposition program with no pivoting. This is typical of my work, which deals with the handling of large linear systems of equations. My benchmark was run with double-precision real variables. The compilers were timed for performing a decomposition followed by a forward-backward substitution pass, thus solving a set of linear equations for one right-hand side vector. The tests were executed on a PC/AT with an 80287 numeric coprocessor.

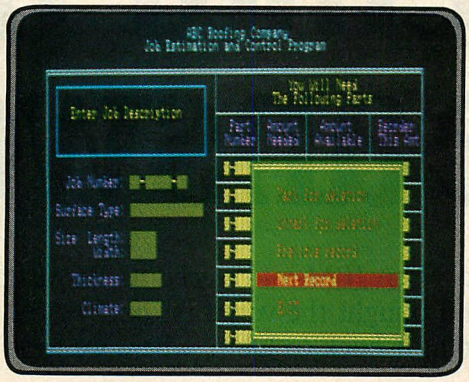
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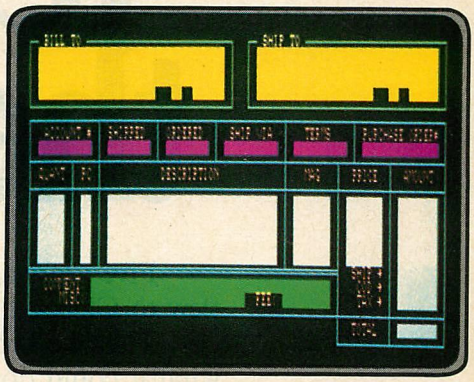












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I recorded two sets of results: one compilation under the assumption that the adjustable arrays could not exceed 64KB, one assuming they could. (This involved the /B option for the IBM product and the $LARGE metacommand for Microsoft.) The two compilers are comparable in speed when the arrays are limited. Moving to the larger array, Microsoft showed an increase in runtime of approximately 16 percent (from 26.64 to 30.81 seconds for 75 equations); IBM, however, was killed by an increase of 143 percent (from 28.07 seconds for the limited-size array to 68.33 seconds for 75 equations).

I was astonished by the huge increase in runtime for IBM when compiling with large arrays, so I created a simple program fragment that multiplies two vectors together [a]*[b]. Microsoft FORTRAN handles the segment selectors using the normal register arithmetic; IBM Professional FORTRAN uses the math coprocessor to do the integer arithmetic for the segment selection. While the math coprocessor is *very* effective in floating-point operations, using it to do the integer arithmetic for segment selection is just not right way to get the job done. Using the Intel timing data shows that just the simple expression SUM = SUM + A(I)*B(I) reflects the percentage increases in the runtimes discussed above.

If the large difference in execution time wasn't bad enough, IBM Professional FORTRAN does not support overlaid programs. Neither did the Lahey standard system (the last time I checked). An overlay structure is essential to a large FORTRAN program.

My experience with the compilation times also does not match Mr. Howard's. With my largest module of 806 lines, Microsoft compiled in 1:33 seconds (omitting PAS3, which is not required for normal use) versus 2:38 for IBM. I also prefer the compilation diagnostic scheme of Microsoft. Its default issues just the compilation errors to the screen. The IBM default just tells the user how many errors and warnings were found, but not where they are in the source code.

Mr. Howard chides Microsoft for using metacommands embedded in the source file for controlling 8087 code generation and other compiler options. This is a legitimate complaint when developing programs and wanting to try different compiler options, but once the compiler options have been decided, it is very convenient to have them built into the code and therefore not have to

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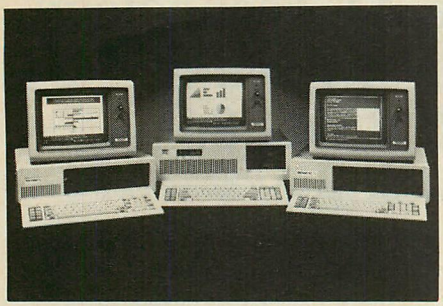
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remember them every time one wants to recompile a module.

Based on my results, IBM FORTRAN is not the professional's choice for developing large FORTRAN applications. I am amazed that Ryan-McFarland advertises that "RM/FORTRAN is the fastest, most powerful FORTRAN made for the PC, XT, AT, or compatible," when this does not bear out.

Finally, DRI is not the only compiler of the four tested that supports both the large and small memory models (as the article stated). As I have just discussed, both IBM and Microsoft do. In addition, Lahey supports *only* the small memory model. I called Lahey and was told that its version 2.0 will be the first version to support over 64KB.

Bob Norton
Sunland, CA

*Mr. Norton has identified a significant problem with IBM FORTRAN with respect to the indexing of very large arrays—larger than 64KB. I contacted Ryan-McFarland and found that all integer*4 operations are performed using the 8087. Release 2.0 of the RM/FORTRAN compiler uses integer arithmetic for integer*4 operations including large array subscript calculations.*

I did not address the question of overlaid programs because they are normally provided by the linker and operating system, and, therefore, were beyond the scope of this review.

In my view, the use of embedded metacommands is a nuisance even when a single compiler has been selected for a project. Each source file must include the metacommands, whereas the use of a batch file or default include file solves the problem with no additional effort by the user.

I should have been more precise on definition of the memory models and size restrictions of the various compilers. I took the DRI definition for small model: code restricted to 64KB and all data restricted to 64KB. All other models were lumped together as large.

—Alan Howard

Your review of FORTRAN compilers was enlightening and I am glad to see that FORTRAN is being considered as a language for personal computers. I would like to offer some additional insights on both IBM Professional FORTRAN and the Microsoft compilers.

We ported a large process simulation program (about 12,000 executable lines) from a mainframe environment to the PC. Our concerns were the number of changes to be made, runtimes for selected problems, and code size. We used an AT with 640KB, an 80287, and a 20MB disk. Microsoft compiled it in 30 minutes with a link time of 10 minutes; its executable code size was 365KB and the runtime for a sample problem was 120 seconds. The comparable figures for IBM were a 60-minute compile time, link time of 10 minutes, executable code size of 415KB and sample problem runtime of 180 seconds.

The sample problem is a simulation of a pulp mill that we use to the test code on various machines. Comparable execution times are about 40 cpu seconds on a VAX 11/750 and about 2 seconds on an IBM 3081. The same FORTRAN code runs on all machines.

One major limitation of the Microsoft compiler surfaced. A 64KB segment (D group) is reserved for the stack, heap, program constants, file buffers, and other miscellaneous uses. Microsoft treats FORMAT statements as program constants and, hence, they reside in D Group; they are not relocated with the code. Programs with a large number of FORMATs may push D group to its limits. In our case, we had in excess of 58KB of FORMAT type data and thus were limited in file usage, after room was reserved for the stack and heap. Also, in version 3.2 (apparently corrected in version 3.3) data initializations of several arrays local to subroutines were "lost" or not done.

Professional FORTRAN was not without problems. The lack of nested INCLUDEs meant a lot of work with a word processor to get the code in a form acceptable to the compiler. Also, The number of constants that could be specified in a DATA statement in the BLOCK DATA subprogram was limited. An attempt to specify more than 140 separate items in the DATA statement (for a single array) generated a compiler error. Thus, DATA A/1200 * 0./ was acceptable, but DATA A/0,1,2..../ was not (assuming A had been dimensioned with 1,200 elements).

Peter E. Parker
The Institute of Paper Chemistry
Appleton, WI

Thank you for your comments on a large system. It is clear from this letter and the others that no single compiler is right for every user. As Professor Maurie Halstead always said, "If there is more than one way to measure something, no one has found the right way."

—Alan Howard

PASCAL



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Highly productive programming and learning environment for the Pascal language that consists of a syntax directed editor, an interpreter and a debugging facility. Syntax templates for every Pascal command provide immediate syntax layout and reduces keying. Because ALICE knows the rules and syntax of Pascal, it's impossible to create a program with syntax errors. User controlled indentation creates structured programs without having to set tabs. There are also Undo and Redo commands for correcting mistakes. During debugging, you can single-step or trace program execution while the cursor follows the currently executing commands. A Code Hiding feature gets commonly used routines out of the way while debugging. Immediate execution mode allows dynamic changing of variables and program statements while the program is running. Source code created using Alice can be compiled with your favorite Pascal compiler including Turbo Pascal and MS Pascal. All these features, combined with its dynamic HELP facility with over 500 screens of on-line help, make ALICE a uniquely productive tool for the Pascal language. Requires 256K memory.

Btrieve by SoftCraft		245	**199**
	Xtrieve	195	**169**
	Rtrieve	85	**79**

Memory resident library of high speed, B-tree file management functions for Turbo Pascal and other languages such as APL, BASIC, C, COBOL, FORTRAN and MS Pascal. With this system, you can create very large files and quickly access records by key values. Its advanced, built-in data integrity feature prevents the incomplete updating of files due to power failure. New records reuse the space made available by deleted records. When a file grows to fill a disk, it can span two physical disks for that one logical file. Xtrieve is a powerful, menu-driven system for displaying and editing information from Btrieve databases. It supports a wide range of retrieval criteria and can perform basic mathematical calculations of information including counts, sums, averages, maximum and minimum values. Rtrieve is a menu-driven report writer used with Xtrieve for generating customized reports, form letters, mailing labels and statements. No royalties on applications created with Btrieve.

FirsTime for Turbo Pascal by Spruce Technology		75	**69**

Syntax directed text editor for Turbo Pascal that takes care of the low level syntax details of your program. You can generate complete statement skeletons with one keystroke. It finds syntax errors and reformats statements after changes. It can also identify errors such as undefined variables, types and constants, assignment statements with type mismatches and errors in include files and macro expansions. Also available for the C language ($239) and MS Pascal ($199).

On-Line Help from Opt-Tech Data Processing		149	**119**

Powerful utility for adding help windows and instruction screens to your programs. You create the help texts with your own text editor and then use the On-line Help Library Manager to translate them into a compact library. You make calls in your code to the library interface to retrieve and display the text in windows. The utility can be interfaced with many different languages. It's fast, compact and an ideal way to add highly maintainable, on-line helps to your system.

Turbo ASYNCH by Blaise Computing		100	**89**

Library of interrupt-driven, asynchronous communications functions for Turbo Pascal. Features include initialization of COM ports, data transfer between circular queues and communication ports, simultaneous buffered input and output to both COM ports, user-defined buffer size, speeds to 9600 baud and XON/XOFF protocol. It installs as a memory resident runtime system and requires about 3.2K of memory. No royalties and includes source code.

		LIST	OURS
Screen Sculptor by Software Bottling of NY		125	**109**

Complete, easy to use system for creating full-screen input for Turbo Pascal and BASIC programs. Screens are created and edited with an interactive screen editor and then transformed into customized, fully-commented, program source code. The editor includes an on-line help system and allows you to draw lines and boxes, enter and manipulate fields and text, resequence input fields, repeat the last character and more. Field definitions include character validation types (pictures), color attribute control, input masks, variable names, initial values, range checks, protected characters and much more. The screen editor requires 128K memory.

Turbo Pascal by Borland International		70	**49**
	with 8087 or BCD	110	**79**
	with 8087 and BCD	125	**85**

Popular, small memory model implementation of the Pascal language that provides very fast compilation and execution of programs. The easy to use, full screen text editor is integrated into the compilation process to allow fast debugging of programs. When the compiler encounters a syntax error, it displays the affected code, enters edit mode, allows you to correct the error and then instantly recompiles. It supports color, sound, DOS paths, windowing, turtle graphics, I/O redirection and much more. Automatic overlays are provided so that large programs can run on small systems. Included is a sample spreadsheet program with complete source code. If your computer has a math coprocessor chip, the optional 8087 support will provide faster execution of programs that use floating point. The optional BCD package provides binary coded decimal arithmetic routines that eliminate roundoff errors. The high quality and low cost of this widely used Pascal compiler makes it a super system for professional software development. Turn the page and refer to the section entitled Turbo Pascal and Utilities for a complete price list for all Borland Turbo Pascal support products and much, much more.

Turbo POWER TOOLS by Blaise Computing		100	**89**

General purpose library of functions for Turbo Pascal. Includes extensive string handling, high speed screen and window management and access to BIOS and DOS services. It also provides the ability to build interrupt service routines and execute other programs including DOS commands and batch files from the calling program. No royalties and includes source code.

Turbo Professional by Sunny Hill Software	New version	70	**59**

Library of functions for creating memory resident routines that can pop up from within other applications at a keystroke. Features include interrupt service routines with control of CPU registers, keyboard macros, BIOS keyboard control, high-level access to environment variables, DOS memory allocation and DOS program execution. Also includes a high speed windowing and screen system, easy DOS date/time access, concurrent printing under DOS 3.x and various sample programs. This new version now adds raw disk I/O, directory searches, 8087 support for pop ups and much more. Includes complete source code in Pascal and Assembler with no royalties. Requires 128K memory.

TurboPower Utilities by TurboPower Software		95	**89**

Set of Turbo Pascal programming utilities that includes a pretty printer, Pascal structure analyzer, execution profiler and execution timer. Also includes a pattern replacer, difference finder, command builder, file finder and super directory. Includes 500K of complete documented source code and 140 page user manual. Requires 192K memory.

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artificial intelligence

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EXSYS *Expert System Development Software*	395	339
GCLISP *Golden Common LISP* by Gold Hill ... *All Models*	Call	Call
Insight I by Level Five Research ... *AI Primer*	95	79
Insight II by Level Five Research	485	399
LISP by Microsoft	250	189
Methods *Prototyping Utility* by Digitalk	250	219
Prolog-86 by Solution Systems	125	Call
Small-X by Kaplan ... *New*	Call	Call
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8088 Assembler *w/Z-80 Translator* by 2500 AD	100	89
Advanced Trace-86 by Morgan Computing	175	149
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Pasm86 *Macro Assembler* by Phoenix Software	295	219
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Periscope II by Data Base Decisions	145	129
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Pfix-86 Plus *Symbolic Debugger* by Phoenix	395	289
The PROFILER by DWB Associates	125	109
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BetterBASIC by Summit Software	200	169
8087 Math Support	99	89
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Datalight C Compiler	60	49
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Eco-C Development System by Ecosoft ... *New version*	100	89
Lattice C Compiler from Lattice	500	Call
Lattice C from Lifeboat	500	299
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Wizard C by Wizard Systems ... *Includes lint*	450	389

c utilities

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Btrieve by SoftCraft	250	199
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C-lib by vance info systems	195	139
The C Library by Kris Jamsa Software ... *New*	90	79
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ESP for C and Pascal	200	159
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lattice products

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TopView Toolbasket *Funcion Library*	250	199
with Source Code	500	395

microsoft products

C Compiler	395	259
COBOL Compiler	700	495
Fortran Compiler ... *Links with Microsoft C*	350	229
LISP	250	189
Macro Assembler *w/utilities*	150	109
Microsoft Windows	99	89
MS Sort	195	149
Pascal Compiler ... *Links with Microsoft C*	300	219
QuickBASIC Compiler	99	79

other languages

Janus/ADA C Pack by R&R Software	95	89
Janus/ADA D Pack by R&R Software	900	699
Level II COBOL by Micro Focus	1500	1269
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PC/Forth by Laboratory Microsystems	150	119
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Turbo PASCAL w/8087 & BCD	125	85
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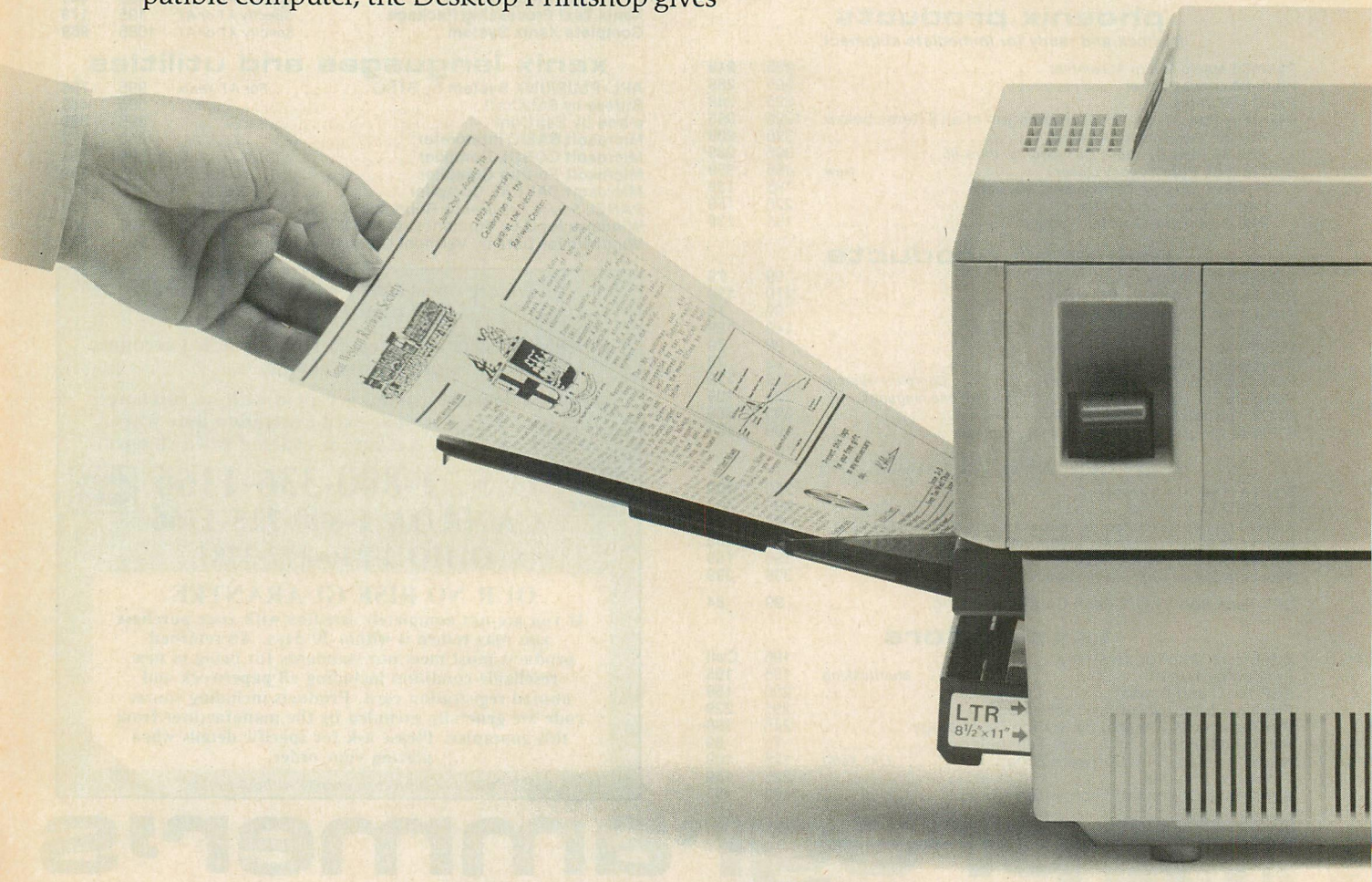
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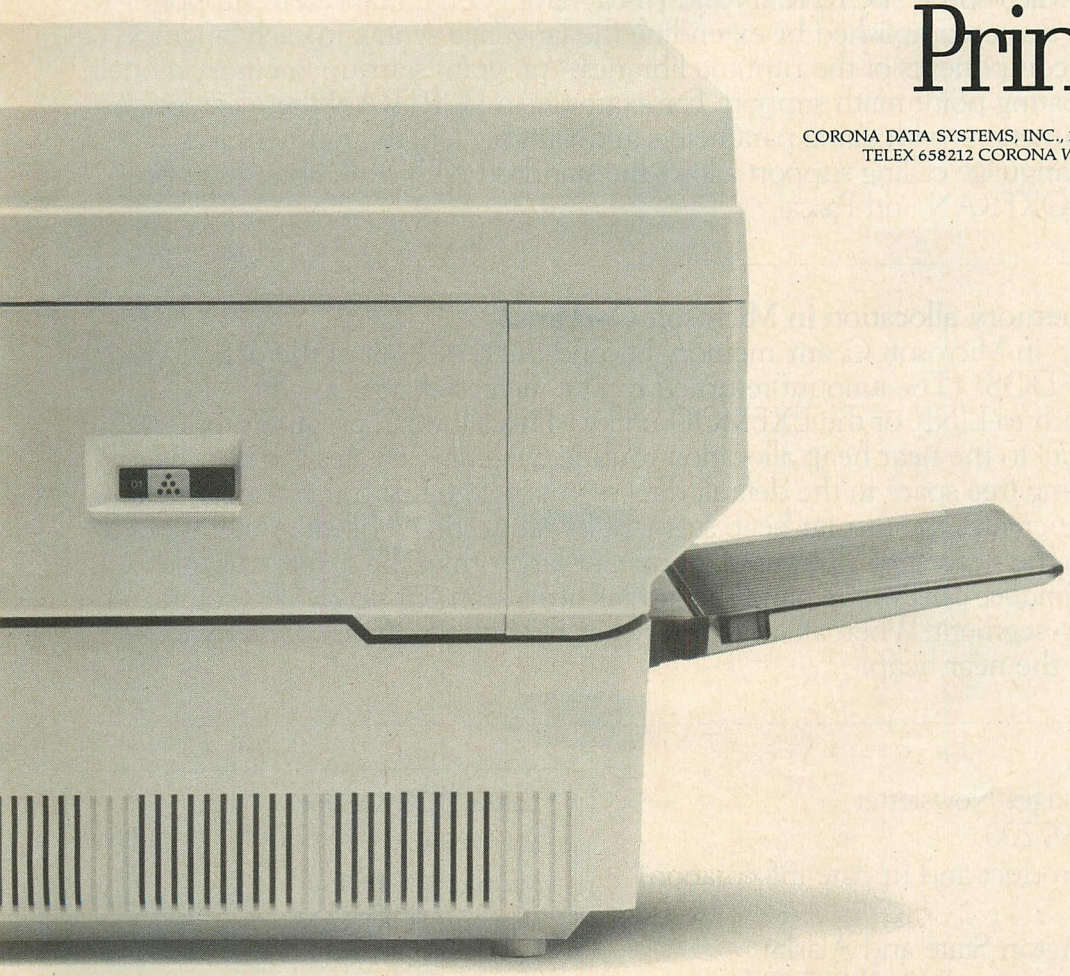
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MICROSOFT LANGUAGES NEWSLETTER Vol. 1-3

News about the Microsoft Language Family

Structured programming in QuickBASIC—Part 1—Subroutines

The Microsoft® QuickBASIC Compiler provides powerful structured programming features that go far beyond BASICA's FOR/NEXT, WHILE/WEND, and GOSUB statements. True subroutines with scalar and array parameters are easy to use in QuickBASIC. All variables in subroutines are local unless they are declared as shared global variables in the current module, as shown below.

```
CALL MySort (howbig, Array())          'sort Array ()
    ...
SUB MySort (limit, Sieve (1)) STATIC   'Sieve is 1-dim
SHARED bubbles                         'global variable
        ...'MySort subprogram body
END SUB
```

QuickBASIC modular programming with separate compilation and subroutine libraries will be covered in Part 2.

Interlanguage calling support added to C, FORTRAN and Pascal

The current releases of Microsoft C, FORTRAN and Pascal have been enhanced to support interlanguage calling. This was accomplished by extending the language syntax in each language and by sharing the major components of the runtime libraries—program start-up, memory models, memory allocation and floating point math support. For example, in FORTRAN these extensions allow programs to call C functions with value parameters and variable length argument lists. Under XENIX,® the interlanguage calling support allows the standard XENIX C libraries to be accessed from Microsoft FORTRAN and Pascal.

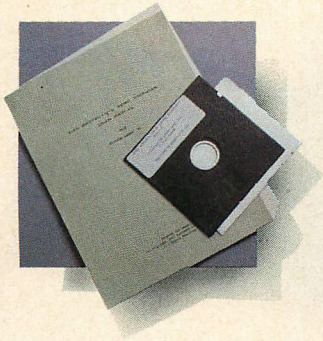
Mixed model dynamic memory allocation in Microsoft C—Part 2

During program start-up in Microsoft C, any memory beyond the 64K limit of the default data segment is released to MS-DOS.® (The amount returned can be increased by using the /CPARMAXALLOC switch to LINK or the EXEMOD utility.) This allows C programs to "exec" child programs. The first call to the near heap allocation routine, *_nmalloc*, creates the near heap which can use the remaining free space in the default data segment. The first call to the far heap allocation routine *_fmalloc*, creates the first far heap segment by requesting a block of memory from DOS rounded up to the nearest 8K (power of 2 equal or larger than the global variable *_amblksiz*). Subsequent *_fmalloc* calls will expand the last far heap segment up to 64K before allocating another far heap segment. When all far memory has been used, *_fmalloc* will try to allocate the memory from the near heap.

Write to: Microsoft Languages Newsletter
10700 Northup Way, Box 97200
Bellevue, WA 98009 for product and update information.
Or phone:
(800) 426-9400. In Washington State and Alaska,
call (206) 828-8088. In Canada, call (800) 387-6616.

Latest DOS Versions:	
Microsoft C	3.00
Microsoft COBOL	2.10
Microsoft FORTRAN	3.31
Microsoft Macro Assembler	4.00
Microsoft Pascal	3.31
Microsoft QuickBASIC	1.00

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Prototypes in Motion

Dan Bricklin's Demo Program enables designers to develop working prototypes of software built on the groundwork of a good user interface, so important in today's market.

All too often, written specifications stop short once the system's required tasks have been described in functional terms without any consideration for the face the system will present to the end user. Interface considerations often are left to the whim of the programmers on the coding team.

Simply getting the job done is no longer enough. Today software is judged on how easy it is to learn and use, how fatiguing it may be to operate for long periods of time, and simply how elegant the screens appear. These concerns cannot be addressed by trial and error. A quality user interface will reflect genuine study and work, and, presumably, testing with real users. As this aspect of development becomes dominant, developers come to realize that the nature of the user interface can strongly influence the shape of the underlying system. If user considerations are critical in marketing a software product, it makes sense to create the interface first and work backwards.

Tools designed for interface prototyping were nonexistent heretofore. Traditionally these prototypes have been produced by actually coding small portions of the program, minus their "inner workings." Besides being a lot of work, this opens the door to slapdash programming by forcing programmers to code before the whole system is fully (or even *mostly*) understood. The appearance, therefore, of an interface prototyping tool such as Dan Bricklin's Demo Program is to be applauded. *PC Tech Journal* has designated it Product of the Month for March 1986.

The Demo Program is a variation on the slide-show concept. The user designs a text screen by arranging characters and attributes on his CRT using the Demo Program's built-in editor. The screen is then compressed and stored in RAM, not as a disk file. By confining the screens to text rather than graphics, a screen can be stored in very little memory and moved quickly into the video refresh buffer.

Commands stored with the screens can control how the screens are displayed. The order in which the screens appear can be controlled by the user. Programmable delays can be inserted between screen displays; programmable tones also are available as commands. Portions of screens can be saved as overlays for quick superimposing upon any given screen.

Using these features, a "hollow" program can be devised without doing any actual programming. Designing screens on paper grids becomes unnecessary. With the help of the Demo Program, a specs group can hand the coders both a functional spec document and an animated simulacrum of the system under design. Moving through layers of menu, bringing up help screens, and triggering error messages are all performed easily. More importantly, the interface can be demonstrated to the end users of the system long before coding ever begins.

PRODUCT
Dan Bricklin's Demo Program

COMPANY
Software Garden, Inc.

ADDRESS
P.O. Box 238
West Newton, MA 02165

TELEPHONE
617/332-2240

PRICE
$74.95

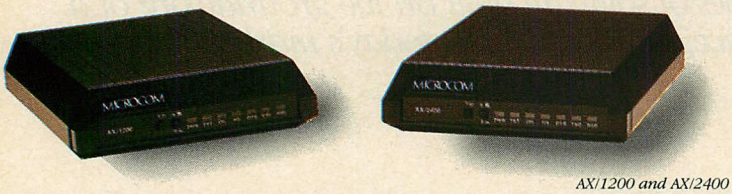
A more ambitious application of the Demo Program might be to determine the bounds of acceptability of program complexity and computational delay. By varying the programmable delays between screens to simulate computation time, the systems group could determine by survey, for example, how long of a delay is considered acceptable by users. Such data can be invaluable to the system design group in deciding just how much computation may be practical given the limits of the target hardware.

The Demo Program editor is function-key driven, with a very clean design. Rectangular blocks of text can be defined and moved, cut from one screen and pasted onto another. One keystroke copies the current screen into the following (empty) screen, making animation by successive modification of a master screen design fast and easy. Boxes can be drawn by determining a fixed and movable corner and adjusting the box size with cursor keys; boxes can be produced in any IBM ROM character. Attributes for portions of a screen can be controlled separately.

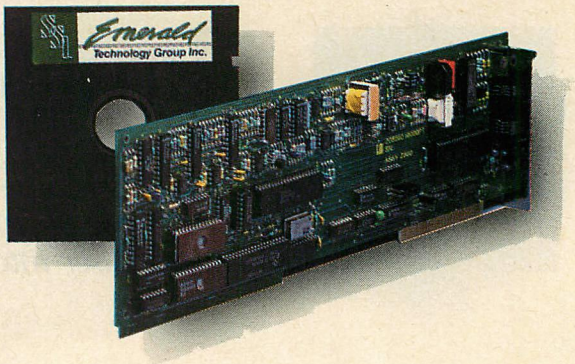
A screen-capture resident utility is provided so that "snapshots" of text screens produced by other programs may be written to disk and imported to the Demo Program editor. Furthermore, screens can be exported in two formats, one that is compatible with current practice in Pascal, and a second that is compatible with C, so that once the prototyped system is coded, the Demo Program's screens can be incorporated directly into the source code files.

Aspects of this product do leave room for improvement, particularly the mimeographed documentation, which is copied from a dot-matrix printout. The addition of a simple command interpreter that could respond to text commands would make a simulated program much more believable, and would permit testing of the mnemonic quality of command structures. Still, remembering that Dan Bricklin invented the spreadsheet as the microcomputer world knows it, his Demo Program might be expected to become *the* essential tool in the neglected area of user interface prototyping.

Hardware, software, and other developments for the IBM PC family



AX/1200 and AX/2400 by Microcom



PC/5251 MATE

FROM IBM

The **IBM Virtual Machine/Personal Computer (VM/PC) Release 2** enhances the usability and performance of the PC/AT-370. New features include support for a DOS session with local and host sessions via a "hot key," APL2 character support in the local CMS session, support for the AT-370 Option Kit in the new model AT with 30MB fixed disks, and an increased number of supported IBM printers. Facilities for using the PC Network Program Redirector functions allow shared printers for high-speed or quality printed output, AT-370 CMS batch server machines, data exchange among AT-370 users, and shared files. The **VM/PC Host Server licensed program (5664-319)** for the host VM system supports communication between an AT-370 or a PC/AT with the AT-370 Option Kit installed and a VM host via a 3270 coaxial connection. It provides spool, disk, and file services; VM/PC service request processing, and support of VM/PC reader, punch, and console commands. VM/PC, $1,150; VM/PC Host Server, $2,000.
IBM Corporation, National Accounts Division, White Plains, NY 10604, National Marketing Division, Atlanta, GA 30327; Contact the local IBM dealer, 800/426-2468

CIRCLE 301 ON READER SERVICE CARD

HARDWARE

A lightweight, 9-track, one-half-inch magnetic tape subsystem for the PC, PC/XT, and PC/AT has been introduced by **IBEX Computer Corporation**. The **TS-100** subsystem features up to 130MB storage capacity on a 10½-inch reel and data transfer rates of as high as 160KB per second. It offers recording formats of 1,600 and 3,200 bpi that are IBM and ANSI compatible. The tape transport system is operated by front panel controls and features self-testing diagnostics of all internal functions. $5,950.
IBEX Computer Corporation, 20741 Marilla Street, Chatsworth, CA 91311; 818/709-8100

CIRCLE 302 ON READER SERVICE CARD

The **PC/5251 MATE** is an integrated communications facility designed to simplify communications between IBM Systems 34/6/8 and remote PCs. Developed by **Software Systems, Inc.**, **Emerald Technology Group, Inc.**, and **Universal Data Systems**, and marketed by Emerald, MATE is the first product to integrate 5251-12 terminal emulation, a synchronous modem, and an autodialer on a single PC board. It is available in two configurations. The MATE-24 includes a 2400-bps, 201C-compatible modem and is used in dial-up operations; the MATE-48 has a 4800-bps, 208A/B-compatible modem and can be used in dial-up or leased-line configurations. MATE-24, $1,395; MATE-48, $1,195.
Emerald Technology Group, Inc., 1601 116th NE, Suite 102, Bellevue, WA 98004, 206/462-8200

CIRCLE 303 ON READER SERVICE CARD

The **AX** family of error-correcting modems has been announced by **Microcom, Inc.** It consists of five new modems ranging in speeds from 1200 bps to 9600 bps for use over two-wire dial-up lines. Each member is Hayes and Microcom command-set compatible and each represents the announcement of three new classes of MNP (Microcom Networking Protocol) technology.

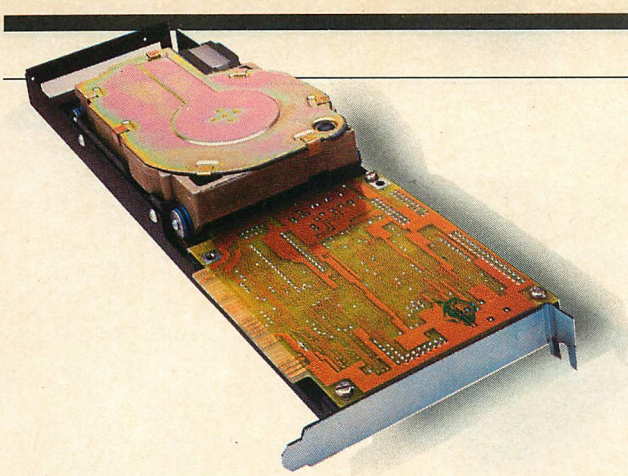
MNP class 4 modems include the **AX/1200** and **AX/2400**. They implement two new techniques to increase throughput: the adaptive packet assembly constantly monitors phone line conditions for noise and interference, and automatically adjusts data packet size accordingly; data throughput is optimized by minimizing protocol overhead. The **AX/24004c** implements MNP class 5 and includes the features of class 4 plus a compression technique, providing typical throughput on text files of 4800 bps. When not in compression state, the AX/2400c is compatible with other V.22 bis and 212A modems.

MNP class 6 products include the **AX/9612c** and **AX/9624c**. These 9600-bps modems include class 4 and 5 features plus two other advancements: statistical duplexing permits adjusting the line bandwidth and data traffic flow for a maximum throughput of 19,200 bps, and universal link negotiation permits class 6 modems to connect with Bell 212A and 103, and V.22 bis modems, and then negotiate to the highest mutually acceptable speed. AX/1200, $499; AX/2400, $749; AX/2400c, $899; AX/9612c, $1,599; AX/9624c, $1,799.
Microcom, Inc., 1400A Providence Highway, Norwood, MA 02062; 617/762-9310

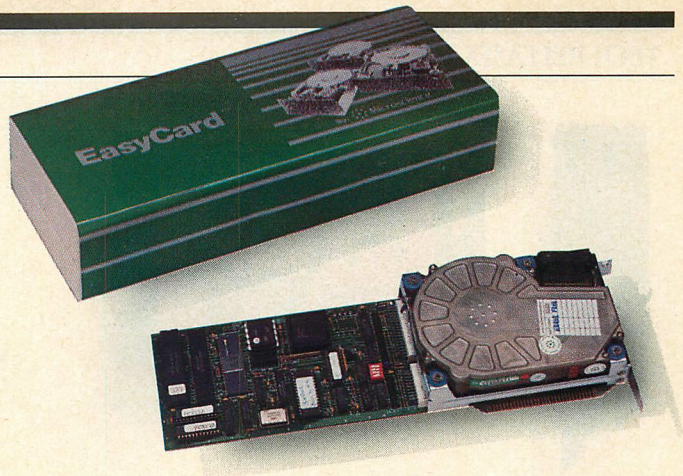
CIRCLE 314 ON READER SERVICE CARD

Four new monitors offering built-in touch capability have been announced by **MicroTouch Systems, Inc.** The line includes the standard resolution **RGB*Touch Monitor** and the high resolution **Enhanced*Touch Monitor** (both PC-compatible color displays), the **NTSC*Touch Monitor**, a color display for videodisk applications, and the **Amber*Touch Monitor**, a monochrome display that accommodates both composite video and IBM-compatible TTL input. The MicroTouch screens feature a solid glass sensor with a sensitive coating bonded to the surface that senses the location of a capacitive coupling when touched by a finger or conductive stylus. RGB*Touch, $1,695; Enhanced*Touch, $1,995; NTSC*Touch, $1,845; Amber*Touch, $1,195.
MicroTouch Systems, Inc., 400 W. Cummings Park, Woburn, MA 01801; 617/935-0080

CIRCLE 319 ON READER SERVICE CARD



Tandon's DISKARD



By Microscience

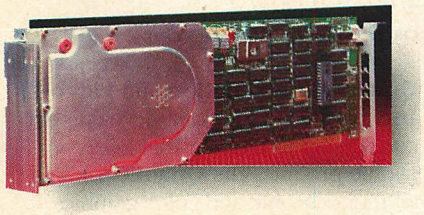
A complete LAN system designed to support 10 PC-based workstations has been announced by **Nestar Systems, Inc.** Called the **PLAN 3000**, this system includes the PLAN 3000 file server; network console (CRT); Nestar's Shadow sofware, PLANPak, and starter library of network-licensed multiuser applications software; an integrated print server coprocessor; 10 token-passing network interface cards; and 16-port HUB. The file server provides 68MB of formatted disk storage and a 45MB streaming tape drive for backup. $16,995.
Nestar Systems, 2585 E. Bayshore Road, Palo Alto, CA 94303; 415/493-2223
CIRCLE 316 ON READER SERVICE CARD

Several companies have introduced 20MB versions of the new disk-drive-on-a-card; the products install in any standard PC slot. From **Microscience International** comes **EasyCard**, which features easy installation, low power consumption (less than nine watts during normal operation), and its own microprocessor that tests the disk drive during power-up and makes repeated checks of the drive's performance during operation. $1,095.

Tandon Computer Products offers the **DISKARD 21** add-in card with integral Winchester disk drive, offering 21.3MB of formatted disk capacity. Its media are plated, and it has a power consumption of 11 watts. $995.

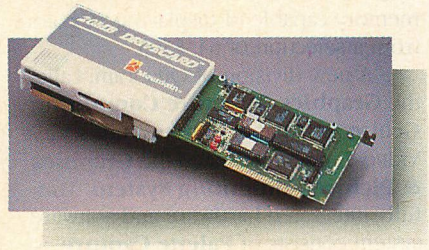
AK Associates has announced **HC 2045**; this drive-on-a-card has an average access time of 45 ms, a low power consumption (also less than 9 watts), and reliability features that include plated media with carbon overcoating. It removes easily for transporation and security purposes; the product is designed to withstand a 40-g nonoperational shock. Full resident diagnostics are standard. Under $1,000 in OEM quantities.

Finally, the **DriveCard** from **Mountain Computer, Inc.**, uses 1½ card slots. The one-half slot portion fills the nonconnector half of a full-card cage slot, leaving the connector open to accept another half card. It comes complete with Mountain's utilities software package. 20MB version, $1,195; 10MB version, $995.
Microscience International Corporation, 575 E. Middlefield Road, Mountain View, CA 94039-7575; 415/961-2212
CIRCLE 308 ON READER SERVICE CARD
Tandon Corporation, 20320 Prairie Street, Chatsworth, CA 91311; 818/993-6644
CIRCLE 311 ON READER SERVICE CARD
AK Associates, P.O. Box 69, Manhattan Beach, CA 90266-0069; 213/379-9616
CIRCLE 309 ON READER SERVICE CARD



20MB HC 2045 by AK Associates

Mountain Computer, Inc., 360 El Pueblo Road, Scotts Valley, CA 95066; 800/485-0300; in California, 800/821-6066
CIRCLE 310 ON READER SERVICE CARD

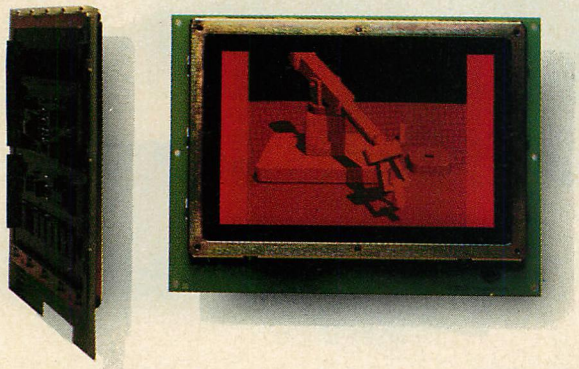


By Mountain Computer

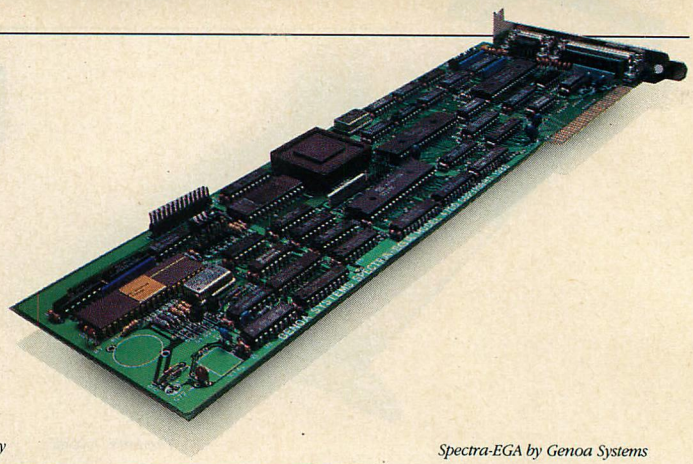
An enhancement board for the PC and PC/XT that increases processing speed by more than 300 percent has been announced by **Everett/Charles Marketing Services, Inc.** The **PC Turbocharger** replaces the 8088 with an 8086, which, combined with an increase in the instruction clock speed from 4.77 mHz to 9.54 mHz, results in a tripling of processing speed. It includes an 8088 emulation mode for timing-sensitive programs, maintaining compatibility with all PC software. The product supports a special 8.54-mHz version of the Intel 8087-2 math coprocessor. $1,295.
Everett/Charles Marketing Services, Inc., 6101 Cherry Avenue, Fontana, CA 92335; 800/443-1860; in California, 800/821-0589
CIRCLE 317 ON READER SERVICE CARD

Cogent Data Technologies, Inc. has announced a board-level Winchester hard-disk controller for the PC, PC/XT, and PC/AT. The **Fixed Disk Accelerator** uses a cache algorithm with full-track, read-ahead, and overlapped data transfer to provide speed improvements for disk I/O-bound applications. The FDX is compatible with LANs, can control two hard-disk drives, and allows each disk to be partitioned into four 32MB virtual DOS drives. $995.
Cogent Data Technologies, Inc., 175 West Street, P. O. Box 926, Friday Harbor, WA 98250; 206/378-2929
CIRCLE 312 ON READER SERVICE CARD

Racal-Vadic has introduced a high speed dial-up modem, the **9600VP**, that reduces file transfer and screen fill time. Operating at 9600 bps, with error control and data compression, the 9600VP matches full-duplex, asynchronous protocols or half-duplex, synchronous protocols. Its error and link control procedures optimize thoughput on noisy lines and offer automatic originate and answer, front-panel dialing and diagnostics, software-configurable options, and support for Racal-Vadic and extended AT dialing protocol command sets. The 9600VP operates synchronously at 9600, 7200, 4800, or 1200 bps. $1,495.
Racal-Vadic, 1525 McCarthy Blvd., Milpitas, CA 95035; 408/946-2227
CIRCLE 321 ON READER SERVICE CARD



Planar's EL8358 M flat-panel display



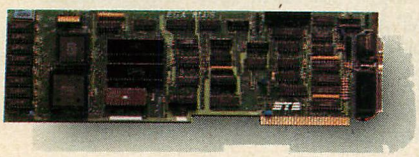
Spectra-EGA by Genoa Systems

The **EL8358 M** from **Planar Systems, Inc.** is an electroluminescent flat-panel display that facilitates the use of graphics, text, and utility software created for DOS-compatible computers. The display is viewable in all ambient lighting conditions and is well suited for industrial control applications. The product's 640-by-200 pixel display provides a resolution of 83 lines per inch. Each pixel is individually addressable for a crisp display image. The unit is a complete monitor, yet only .55 inches thick and weighs only 16 ounces. $775.
Planar Systems, Inc., 1400 N.W. Compton Drive, Beaverton, OR 97005; 503/690-1100

CIRCLE 315 ON READER SERVICE CARD

STB Systems, Inc. has announced the **EGA Plus**, an IBM-compatible Enhanced Graphics Adapter (EGA). The EGA Plus video adapter operates in 16 different text and graphics modes. In addition to its IBM EGA compatibility, the new adapter provides 256KB of standard display memory without the need for the piggyback IBM requires. EGA Plus offers a standard parallel printer port and an optional clock/calendar. With the board, STB bundles PC Accelerator, an intelligent utility software program that provides up to 10 disk emulators and three print spoolers. EGA Plus uses available system memory, PC/AT memory above 1MB, and EMS memory (Lotus/Intel/Microsoft expanded memory specification) through STB's Memory Companion/PC board. EGA Plus, $595.
STB System, Inc., 601 N. Glenville, Suite 125, Richardson, Texas 75081, 214/234-8750

CIRCLE 305 ON READER SERVICE CARD



STB Systems' EGA Plus

The **Spectra-EGA** is a graphics card by **Genoa System Corporation** that supports the advanced IBM graphics standards for the PC, PC/XT, PC/AT, and compatibles. The Spectra-EGA has 640-by-350 resolution, uses a 64-color palette in any 16-color combination, and supports IBM graphics modes and products, including the monochrome/color graphics adapter, all present software, and a color monitor. It features a light-pen interface, bit-mapped graphics, loadable font, programmable cursor, parallel printer port, and 256KB of on-board memory. $495.
Genoa Systems Corporation, 73 E. Trimble Road, San Jose, CA 95131; 408/945-9720

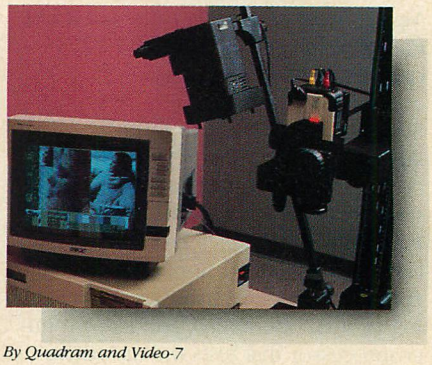
CIRCLE 304 ON READER SERVICE CARD

Quadram Corporation and **Video-7, Inc.** have entered a joint development partnership to offer an IBM EGA-compatible product. The **QuadEGA+** runs all monochrome and color graphics software on the market. The QuadEGA+ carries the full EGA capacity (640-by-350 pixel resolution) in addition to IBM's color graphics adapter (320-by-200) and monochrome text display adapter (720-by-350) and the Hercules standard (720-by-348). It comes with 256KB video memory capable of displaying 16 colors from a selection of 64. $595.

A new division of Quadram, called the **Graphics & Picture Computing Group**, in another joint venture with Video-7, has announced the **Graphics & Picture Computing System**. This fully integrated hardware and software system consists of **Palette Capture**, a printed circuit board that digitizes video input into data; **Palette Master**, a color graphics adapter that can display photographic-quality images; **Imageware.100**, an image creator and picture editor designed to enhance pictures digitized by Palette Capture; **Imagebase**, a database system that merges pictures with data; and **Imageware Toolkit**, a programmer's toolkit for creating customized databases integrated with photographic quality images. Picture Computing System, less than $2,000; a turnkey workstation that includes requisite hardware and software, about $4,000.
Quadram Corporation, One Quad Way, Norcross, GA 30093-2918; 404/923-6666

CIRCLE 306 ON READER SERVICE CARD
Video-7, Inc., 550 Sycamore Drive, Milpitas, CA 95035; 408/943-0101

CIRCLE 307 ON READER SERVICE CARD



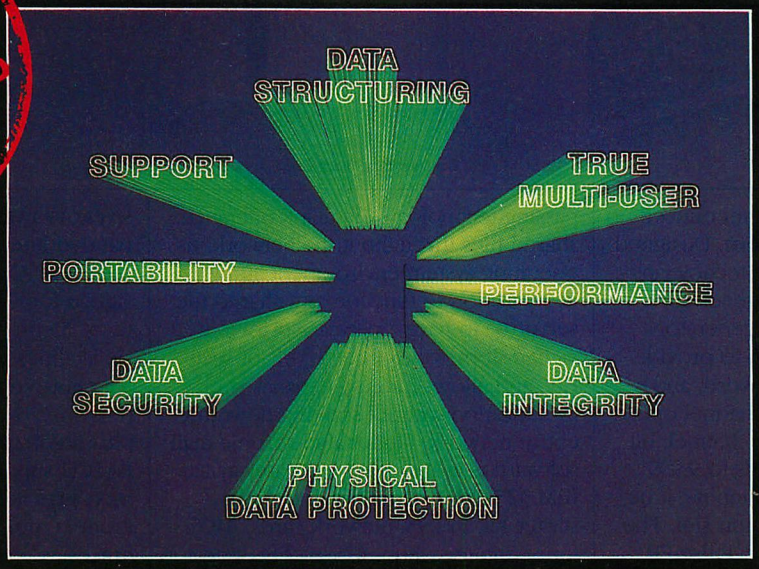
By Quadram and Video-7

Eicon Technology Corporation has announced three products designed to integrate the PC and IBM PC Network with X.25 Packet Switched Networks such as Telenet. The **Network Adapter** is a communications card with an MC 68008, 128KB of RAM, four DMA channels, and two serial ports. A standard RS-232 interface port can support full-duplex data transmission at 64 Kbps. **Attach/X.25** links PC Networks over a packet network. **Access/X.25** supports the standard X.3/X.28/X.29 interface for asynchronous start/stop terminals on public data networks. Attach/X.25 (including Network Adapter) single user, $1,195; multiuser, $1,395; Access/X.25 single user, $995; multiuser, $1,195.
Eicon Technology Corporation, 3452 Ashby Street, Montreal, Quebec, Canada H4R 2C1; 514/333-8543

CIRCLE 318 ON READER SERVICE CARD

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MDBS III®
ABSOLUTE POWER

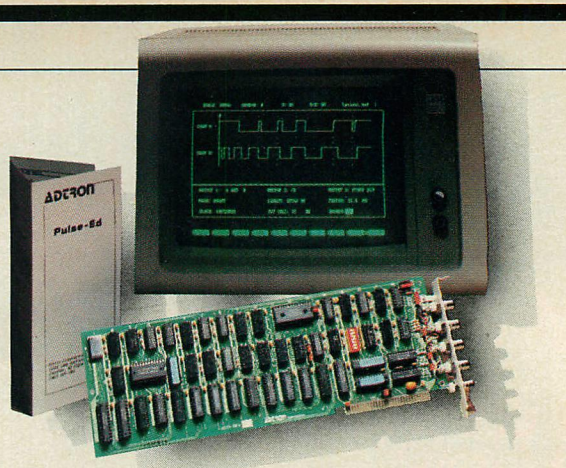
CIRCLE NO. 211 ON READER SERVICE CARD

mdbs is a registered trademark and MDBS III is a trademark of Micro Data Base Systems, Inc. IMS is a trademark of IBM; IDMS of Cullinet.

mdbs®



By Micro Data Base Systems, Inc.



Adtron Data Generation System

Adtron Corporation has announced its **Data Generation System**. Designed for scientists, engineers, or technicians who use digital waveform generators, the DGS consists of a data generator board and waveform editor to provide the capabilities of pattern, word, and pulse generators. Its dual-channel operation offers 32,768 bits per channel, bit widths from 50 nanoseconds to 9.999 seconds, and external sync inputs; it occupies a single IBM expansion slot. The full-screen waveform editor, Pulse-Ed, lets the user manipulate waveforms. When the board and editor are used together, the system provides realtime generation and execution of waveforms. $2,175; quantity discounts available.
Adtron Corporation, 11415 E. Redfield Road, Chandler, AZ 85225; 602/926-1461

CIRCLE 313 ON READER SERVICE CARD

Answer Software's ICD286 (in-circuit debugger), uses a PC, PC/XT, or PC/AT as a host and provides full speed emulation of the 80286 up to 10-mHz clock rates. The ICD286 consists of a control board, an 80286 buffer box that plugs into the 80286 socket in the target system, and a screen-oriented symbolic debugger. This basic product provides upload/download of code and data, hardware and software breakpoints, and single-step and full-speed execution of applications programs. Its REMOTE LOAD feature uses the target system to load the code and symbols into the ICD286 and greatly facilitates the debugging of applications programs on the AT. $2,400.
Answer Software Corporation, 20863 Stevens Creek Blvd., Cupertino, CA 95014; 408/253-7515

CIRCLE 322 ON READER SERVICE CARD

The Davong MulitLink LAN is now available from **Tiara Computer Systems, Inc.** Renamed **TiaraLink**, this high-performance LAN employs proven token-passing technology. TiaraLink offers true shared files throughout the network. Its operating system environment allows every station to function as a shared file server or to have a network printer attached. It provides three levels of security, and allows for easy expansion or modification without shutting down the entire network. Optional electronic mail software is available, as is a gateway to IBM 3274/SNA networks. TiaraLink starter kit, $1,095; network cards, $495; four-connector hub, $75; eight-connector hub, $595; software, $500.
Tiara Computer Systems, Inc., 2685 Marine Way, Mountain View, CA 94043; 415/965-1700

CIRCLE 320 ON READER SERVICE CARD

SOFTWARE

An artificial intelligence (AI) software package for business has been announced by **Micro Data Base Systems, Inc. GURU** combines expert system development tools, natural language capabilities, familiar business computing tools, and four user interfaces in one program. When providing expert system consultations, GURU works with backward and forward chaining, certainty factors, and environment controls, and asks the user for additional information when necessary. GURU provides recommendations and explains its reasoning. Available for incorporation into expert systems developed with GURU are relational database management, spur-of-the-moment inquiry, spreadsheets, forms management, and statistical analysis, comprehensive mathematical capabilities, and report generation. GURU has four interfaces: natural language, menu, a direct English-like command language, and procedural programming. Single-user system, $2,995.
Micro Data Base Systems, Inc., P.O. Box 248, Lafayette, IN 47902; 317/463-2581

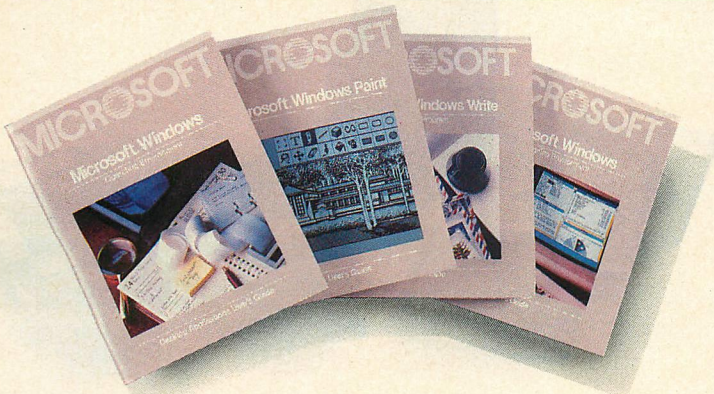
CIRCLE 326 ON READER SERVICE CARD

MYCROFT LABS INC. has introduced an expanded line of its MITE communications products. All of the systems were designed for CP/M-80 and MS-DOS systems. Menu-driven **MICRO-MITE** offers basic facilities to originate calls and transfer readable text. **MINI-MITE** includes password protection, preconfigured plus automatic logons, XMODEM/BATCH support, and review buffer. **MAXI-MITE** adds support for Mac systems; it offers multiprotocol asynchronous functions, including automatic dialing, automatic answering, transfer of binary and text files, and 10 programmable function keys. **MAXI-MITE+** adds a script file command language and terminal emulation to the features of MAXI-MITE. **VERTI-MITE** is specifically designed for individual industries, containing key telephone numbers; it has a quick-search facility. MICRO-MITE, $49.95; MINI-MITE, $95.00; MAXI-MITE, $150.00; MAXI-MITE+, $175.00; VERTI-MITE, variable price.
MYCROFT LABS INC., 2615 N. Monroe Street, Tallahassee, FL 32303; 904/385-1141

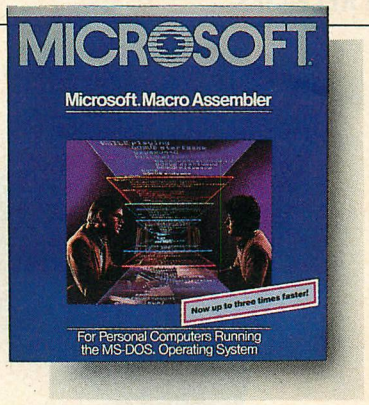
CIRCLE 328 ON READER SERVICE CARD

Softaid, Inc. is now shipping **MT8087**, a BASIC compiler for DOS systems with an 8087 or 80287 coprocessor. MT8087 performs real number computation 30 to 40 times faster than MTBASIC. (MTBASIC compiles in excess of 100 statements per second, so most programs will compile in a couple of seconds and then will run about 50 times faster than interpreted BASIC code.) MT8087 maintains 18 decimal digits of accuracy over a range of 10^{-308} to 10^{308}. Trig, log, and exponential functions also take advantage of the coprocessor's speed and accuracy. It supports multitasking as many as 10 BASIC programs, and makes windowing programs simple. No runtime license is required to distribute the object code. $79.95.
Softaid, Inc., P.O. Box 2412, Columbia, MD 21045-1412; 301/792-8096

CIRCLE 327 ON READER SERVICE CARD



Microsoft Windows



Version 4.0 of Microsoft MASM

Microsoft Corporation has announced the retail shipment of **Microsoft Windows** to dealers and distributors. Windows is an operating environment that extends DOS features while remaining compatible with most existing applications already running under DOS. It lets users integrate tasks by permitting several programs to run at the same time as well as easy switching among them without quitting and restarting. $99.

Also from Microsoft comes a new high-speed version of its Macro Assembler (MASM) language. Microsoft **Macro Assembler 4.0** is three times faster than the previous version, and its new features allow users to assemble larger source files with more symbols and more macro text. New assembly switches make the assembler more convenient and efficient. The documentation has been revised to add more programming examples and it includes the *Intel Programmer's Pocket Reference Guide*. $150; upgrade, $75.
Microsoft Corporation, 10700 Northup Way, P.O. Box 97200, Bellevue, WA 98004; 800/426-9400

CIRCLE 324 ON READER SERVICE CARD

BASIS Incorporated has released **BBx** (Business BASIC Extended), a multiuser, multitasking business BASIC that supports DOS, XENIX, UNIX, and networks from IBM, Microsoft, and Novell. BBx maintains portability and compatibility with existing Business BASIC programs, but adds support for windows, extended variable and function names, string arrays, STRING and DIRECTORY file types, operating system shell commands, and extended screen types, including color. It is written almost entirely in C. Single-user DOS version, $195; IBM, Microsoft, and Novell networks version, $495; XENIX and UNIX version, $695.
BASIS Incorporated, 5700 Harper Drive NE, Suite 290, Albuquerque, NM 87109; 800/UX-BASIS or 505/821-4407

CIRCLE 329 ON READER SERVICE CARD

dBASE III PLUS from **Ashton-Tate** is a complete database management system that combines ease of use and power with built-in multi- and single-user capabilities. Each copy of dBASE III PLUS can be installed on a LAN and support one initial user. All dBASE III programs and files can migrate to the LAN environment and full single-user dBASE III PLUS capabilities are available. dBASE III PLUS's multiuser capability includes file- and record-locking features that provide true multiuser data access without data corruption, eight levels of password protection, and high-speed encryption/decryption of data. $695; to upgrade from dBASE III, $140.
Ashton-Tate, 10150 W. Jefferson Blvd., Culver City, CA 90230; 213/204-5570

CIRCLE 333 ON READER SERVICE CARD



dBASE III PLUS screen

Borland International, Inc. entered an agreement with **IBM Corporation** under which IBM will distribute selected Borland software for IBM PC products through its National Accounts and National Marketing divisions. The first Borland products marketed in this way will be Turbo Pascal and SideKick (non-copy-protected versions). Turbo Pascal, $69.95; SideKick, $84.95.
Borland International, 4585 Scotts Valley Drive, Scotts Valley, CA 95066; 408/438-8400

CIRCLE 325 ON READER SERVICE CARD
IBM Corporation; Contact the local IBM dealer, 800/426-2468

CIRCLE 325 ON READER SERVICE CARD

Quinn Curtis has introduced the **General Science and Engineering Tools Package** for the Turbo Pascal programmer. It includes procedures for general statistics, multiple regression, curve fitting, integration, FFTs, file transfers to Lotus 1-2-3, solving simultaneous equations, matrix math, linear programming, data smoothing, and graphics. The **Turbo Pascal Data Acquisition and Control Tools Package** supplies procedures for analog I/O, digital I/O, thermocouple linearization, PID control, realtime graphics, and FFTs. This package uses Turbo LABLOG and Turbo HSDAS for data logging, high-speed data acquisition, and acquiring and analyzing analog data immediately. Each tool is supplied in Pascal source code format that can be compiled with either Turbo Pascal or Turbo-87 Pascal. Science and Engineering Package, $69.95; Turbo Pascal Data Acquisition Package, $94.95.
Quinn-Curtis, P.O. Box 10, Newton Centre, MA 02159; 617/969-9343

CIRCLE 331 ON READER SERVICE CARD

Version 3.0 of **Epsilon**, the advanced EMACS-like programmer's text editor from **Lugaru Software Ltd.**, incorporates an embedded programming language called EEL, in which end users may modify and extend the editor. EEL is an interpreted implementation of C. Other improvements include support for large displays, such as IBM's Enhanced Graphics Adapter, allowance for buffer-specific key bindings, compiler-specific error packages, and a tagged regular expression search-and-replace facility, as well as other enhancements. In addition, version 3.0 retains Epsilon's concurrent process facility that allows simultaneous execution of the editor and other programmer's tools, such as compilers and linkers. $195.
Lugaru Software Ltd., 5740 Darlington Road, Pittsburgh, PA 15217; 412/421-5911

CIRCLE 332 ON READER SERVICE CARD



From VM Personal Computing *By WATCOM Products, Inc.*

A communications software package, **RELAY Gold**, from **VM Personal Computing Inc.**, features multitasking, a new generation script language, full menu or command-driven operation, flexible screen scrollback, a learning mode, and a tutorial diskette. RELAY Gold allows users to work on any DOS application program, such as Lotus 1-2-3 or WordStar, concurrent with file transfer. Its advanced file transfer protocol allows high-effective character transmission rates as well as the simultaneous swapping of files between two PCs, thus reducing telephone expenses. The **RELAY Gold Customizer's Toolbox** gives applications developers the flexibility to change RELAY Gold's user interface by creating new menus or altering standard menus to fit specific needs. The Toolbox provides a display interface, advanced information on RELAY Gold's script language, the ability to design and maintain screens as members in panel libraries, and scripts for controlling modems directly supported by RELAY Gold. RELAY Gold, $225; Toolbox, $500.
VM Personal Computing Inc., 6 Germantown Road, Danbury, CT 06810; 203/798-6755

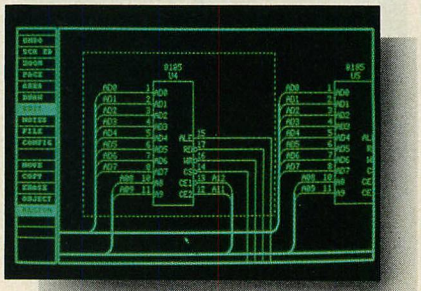
CIRCLE 335 ON READER SERVICE CARD

An MS-DOS version of the **UNIFY** relational database management system has been announced by **Unify Corporation**. The product provides fast execution speeds for large databases and complex applications. It features a full set of development tools including an industry-standard SQL and a fourth generation report writer, and it is UNIX compatible. It also provides a Host Language Interface to the C language for integrating existing or custom subroutines into applications. UNIFY, $995; Host Language Interface, $495.
Unify Corporation, 4000 Kruse Way Place, Lake Oswego, OR 97034-2548; 503/635-6265

CIRCLE 338 ON READER SERVICE CARD

A new full-featured CAE schematic capture program called **SCHEMA** has been announced by **Omation, Inc.** SCHEMA consists of a drawing editor with a mouse-driven user interface, extensive object libraries, and several powerful post-processors and component databases, all included in an integrated package. The drawing editor allows engineers and other professionals to generate accurate, high-resolution schematics without memorizing complex keyboard command sequences or codes. Features include realtime interaction, zooming/panning, regional editing, and command repetition. All drawing must be done with a mouse, which is not included with the package. $495.
Omation Inc., 1701 N. Greenville Avenue, Suite 809, Richardson, TX 75081; 214/231-5167

CIRCLE 336 ON READER SERVICE CARD



SCHEMA screen

An enhanced version of the relational data management system, **DATAEASE 2.5**, from **Software Solutions, Inc.** offers a new procedural language that requires no programming knowledge. New financial and scientific functions have been added, including support for the 8087. An encryption feature secures applications. $600, upgrade, $50.
Software Solutions, Inc., 12 Cambridge Drive, Trumbull, CT 06611; 800/243-5123; in Connecticut, 203/374-8000

CIRCLE 334 ON READER SERVICE CARD

UCSD Pascal and other **p-System** software products, formerly owned by Softech Microsystems, will be enhanced, marketed, and distributed by **Pecan Software Systems, Inc.** The current USCD Pascal release includes dynamic memory management, separate compilation, data-hiding, multitasking, and native code generation to enhance performance and throughput. The p-System is a development environment with facilities for creating and running applications programs. It also includes text processing capabilities and utilities for file and library management, disk recovery, and configuration. UCSD Pascal, $79.95; p-System, $79.95.
Pecan Software Systems, Inc., 1410 39th Street, Brooklyn, NY 11218; 718/851-3100

CIRCLE 339 ON READER SERVICE CARD

WATFOR-77, the latest member of the WATFOR family of FORTRAN compilers, has been released by **WATCOM Products, Inc.** WATFOR-77 supports the full FORTRAN 77 language standard and greatly reduces the program-development cycle. A program is compiled directly into the computer's memory and then executed. One version of WATFOR-77 requires the 8087 math coprocessor and uses the device extensively for both integer and floating-point arithmetic. A second version does not use the 8087 but provides the same level of accuracy in floating-point computations. WATFOR-77 uses all available memory on the PC. One time license fee, $295; annual site license fee for up to 20 PCs, $1,200; for more than 20 PCs, $3,000.
WATCOM Products, 415 Phillip Street, Waterloo, Ontario, Canada N2L 3X2; 519/886-3700

CIRCLE 330 ON READER SERVICE CARD

The material that appears in Tech Releases is based on vendor-supplied information. These products have not been reviewed by the PC Tech Journal *editorial staff.*

Manx Aztec C86
Join The Stampede!

"A compiler that has many strengths ... quite valuable for serious work"
COMPUTER LANGUAGES, 2/85

"Easily one of the fastest compilers overall... library provides a lot of flexibility ... small .EXE files." DR. DOBB'S JOURNAL, 8/85

Manx Aztec C86 - Join the Stampede!

If you are programming in C or plan to program in C for MS-DOS, PC-DOS, CP/M-86, or ROM based 8086/80x86 systems, we invite you to join the stampede to Manx Aztec C86. The stampede to the most powerful, portable, and professional C development system available for MS-DOS and CP/M-86.

Manx Aztec C86 - Power to Spare

In benchmarks published in the February, 1985 issue of Computer Languages and the August, 1985 issue of Dr. Dobb's Journal, Manx Aztec C86 again and again came up on top in benchmarks of code speed, code size, and compile times. Dr. Dobb's Journal declared Manx Aztec C86 the winner in the benchmarks, sharing the honor with the new Microsoft C compiler.

Manx Aztec C86 - Unmatched Portability

Only Manx Aztec C is available for: MS-DOS, CP/M-86, Apple Macintosh, Apple*II*, TRS-80, CP/M-80, and Commodore systems. No other C system comes anywhere close to supporting the number of microcomputer systems that Manx supports.

Manx also, provides ROM development systems for 8086/80x86, 68000, 8080/Z80, and 65xx systems.

Manx Aztec C86 - Fantastic Features

Manx Aztec C86 is heavily bundled with special features and utilities. Features described below are for the Aztec C86-c and Aztec C86-d systems. Features that are only available with Manx Aztec C86-c are marked (-c).

Optimized C compiler: Unsurpassed for code quality and speed. Optionally generates 80186 and 80286 code. Full K & R.

Symbolic Debugger: Execution trace, break points, display data in floating point, integer, character, or hex format. Evaluate expressions. Detect illegal memory stores, modify memory/registers, disassemble code.

Manx AS86 Macro Assembler: Supports macroes, 8086, 80186, and 80286 instructions in Intel format. Fast execution.

LN86 Overlay Linker: Links small, large, and mixed memory model routines. Supports overlays, and options for producing ROM based code.

Librarian: Build and modify personal or system run time libraries.

8087/80287 Sensing Library: One library simulates floating point, another assumes the presence of an 8087 or 80287 math chip, the third senses the existence of a math chip, and if it finds one it uses it.

Profiler: Provides a run time analysis of your code to pinpoint code segments to optimize.

UNIX Libarary: Compatible with UNIX C. Fast I/O. Terminal I/O can be buffered or unbuffered.

DOS Library: Time and date functions, program forking (exec), program chaining, directory commands, I/O port support, sysint support, BIOS functions, and BDOS functions.

Screen & Graphics Library: Screen and cursor functions. Fast routines for drawing lines, circles, ellipses, points, and setting colors.

CP/M-86 Library (-c): Produce programs for CP/M-86.

Large Memory Model: Manx Aztec C86 supports programs and data of any size. Global data has a max size of 64k.

Intel Object Option: Interface to software that requires Intel object format, such as PLINK-86.

Z (vi) Source Editor (-c): Fast, powerful editor, macro capabilities, undo, ctags, buffers for commands and data, and all the bells and whistles that make vi fanatics fanatical.

ROM Support Package (-c): Startup routine, linker options for separate placement of code and data, special utilities like the Intel HEX Utility, documentation, and library source.

Library Source Code (-c): UNIX, screen, graphics, and math function libraries.

Mixed Memory Models (-c): Mix large code and small data, small code and large data, or mix within type.

UniTools (-c): The UNIX utilities **make, diff, and grep.**

One year of updates (-c): As new versions are released, updates are automatically sent.

Technical Support: Manx has a full time staff to provide support via telephone & bulletin board.

Aztec C86-c Commercial System	**$499**
Aztec C86-d Developer's System	**$299**
Aztec C86-p Personal System	**$199**
Aztec C86-z Apprentice System	**$ 49**

Manx Cross Development Systems

Manx Aztec C compilers are available as native or as cross development systems for PC-DOS, MS-DOS, Macintosh, CP/M-86, CP/M-80, TRSDOS, Apple II, and Commodore 64/128.

Cross development involves two computer systems: the development system (HOST) and the executive system (TARGET). This method is useful when the TARGET machine is slower or more limited than the HOST.

HOSTS: VAX UNIX ($3000), PDP-11 UNIX ($2000), MS-DOS ($750), CP/M ($750), Macintosh ($750), CP/M-68k ($750), XENIX ($750).

TARGETS: MS-DOS, CP/M-86, Macintosh, CP/M-68k, CP/M-80, TRS-80 3 & 4, Apple II, Commodore C64, 8086/80x85 ROM, 68xxx ROM, 8080/8085/Z80 ROM, 65xx ROM.

Additional TARGETS are $300 to $500 (non VAX) or $1000 (VAX). Call for information, on cross development to the 68000, 65816, Amiga, C128, CP/M-68K, VRTX and others.

How To Become a Manx-Aztec C User

Call 1-800-221-0440 or 1-800-832-9273 (800-TECWARE). In NJ or outside the USA call 201-530-7997. Orders can also be telexed to 4995812.

Payment can be by check, COD, American Express, VISA, Master Card, or Net 30 to qualified customers.

Orders can also be mailed to Manx Software Systems, Box 55, Shrewsbury, NJ 07701.

For More Information: call 1-800-221-0440, or 201-530-7997, or write to Manx Software Systems.

Support Software for Manx Aztec C86

Discounts are available on many items listed below. Call Manx for details.

C-tree $395: B-tree database system. Easy to use. Available for Aztec C for MS-DOS, Macintosh, CP/M-86, CP/M-80, and others. Includes source.

PHACT $250: Powerful database system. Available for Manx Aztec C compilers for MS-DOS, CP/M-86 and CP/M-80.

PANEL $295: Create screens via simple, powerful editing commands. Select colors, edit fields, Directly input data to a multi-keyed file utility.

SunScreen $99: Create and modify formatted screens easily. Validate fields, select colors, create screens for both the color and monochrome cards. With library source SunScreen is $299.

Windows for C $195: Versatile window utility that supports IMB PC compatible and some non-compatible environments.

HALO $250: The ultimate C graphics package. It supports viewports, shapes, and multiple graphics cards. A less expensive version is available for just the PC mono and color cards.

FirsTime $295: Syntax checking while you edit greatly shortens compile ti.ne.

Pre-C $395: Powerful Lint-like utility locates structural and usage errors. Easily checks multiple files for bad parameter declarations and other interface errors. Lint users will find the user interface a dream come.true.

PC-LINT $98: Link-like utility that supports large memory models, has clear error messages, and executes quickly, has lots of options and features that you wouldn't expect at this low price.

Greenleaf Functions $185: Source for over 200 C and assembler functions.

C Utility Library $185: C and assembler source for screens, windows, color graphics, asynch communications, and more. The color graphics and speed of this package are impressive.

PLINK-86 $395: MS-DOS linkage editor for producing and maintaining overlayed programs. It works with Aztec C86 in Intel object format mode.

Discounts

Discounts are available to professors, students, small businesses, and consultants. A discount is also available on a "trade in" basis for users of "brand x" C compilers. Call Manx for details.

30 Day Satisfaction Guarantee

Any Manx Aztec C system can be returned within 30 days for refund if you are not satisfied with your purchase. Only systems shipped within the USA by MANX directly to the end user are eligible for return. Refunds will not include shipping costs and a small restocking fee may be charged.

Distribution of Manx Aztec C

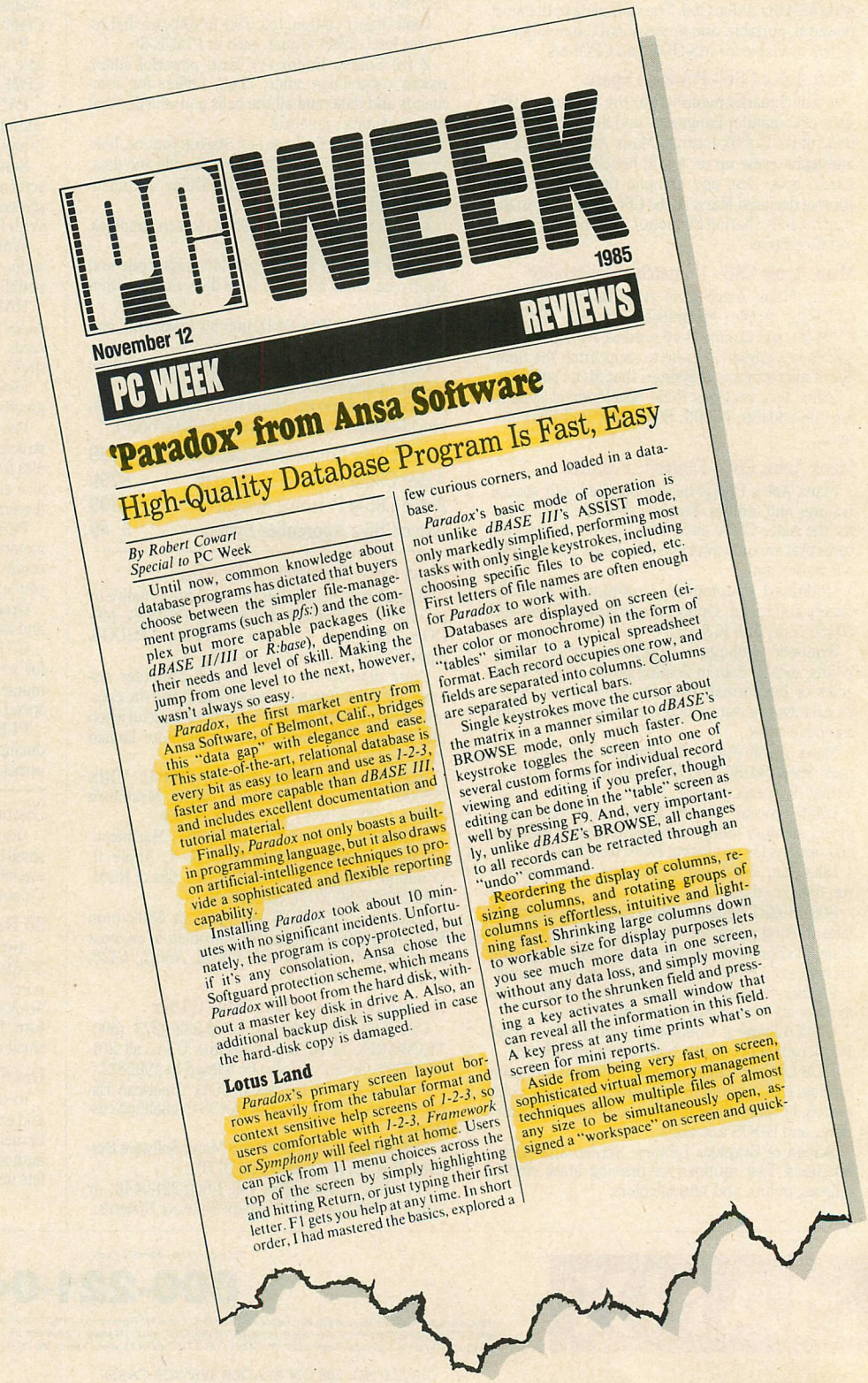
In the USA, Manx Software Systems is the sole and exclusive distributor of Aztec C. Any telephone or mail order sales other than through Manx are unauthorized. Manx Aztec C is sold at some retail outlets under license to Manx.

To order or for information call:

800-221-0440

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If you don't believe advertising, read this



PC WEEK 1985

November 12

REVIEWS

PC WEEK

'Paradox' from Ansa Software

High-Quality Database Program Is Fast, Easy

By Robert Cowart
Special to PC Week

Until now, common knowledge about database programs has dictated that buyers choose between the simpler file-management programs (such as *pfs:*) and the complex but more capable packages (like *dBASE II/III* or *R:base*), depending on their needs and level of skill. Making the jump from one level to the next, however, wasn't always so easy.

Paradox, the first market entry from Ansa Software, of Belmont, Calif., bridges this "data gap" with elegance and ease. This state-of-the-art, relational database is every bit as easy to learn and use as *1-2-3*, faster and more capable than *dBASE III*, and includes excellent documentation and tutorial material.

Finally, *Paradox* not only boasts a built-in programming language, but it also draws on artificial-intelligence techniques to provide a sophisticated and flexible reporting capability.

Installing *Paradox* took about 10 minutes with no significant incidents. Unfortunately, the program is copy-protected, but if it's any consolation, Ansa chose the Softguard protection scheme, which means *Paradox* will boot from the hard disk, without a master key disk in drive A. Also, an additional backup disk is supplied in case the hard-disk copy is damaged.

Lotus Land

Paradox's primary screen layout borrows heavily from the tabular format and context sensitive help screens of *1-2-3*, so users comfortable with *1-2-3*, *Framework* or *Symphony* will feel right at home. Users can pick from 11 menu choices across the top of the screen by simply highlighting and hitting Return, or just typing their first letter. F1 gets you help at any time. In short order, I had mastered the basics, explored a few curious corners, and loaded in a database.

Paradox's basic mode of operation is not unlike *dBASE III*'s ASSIST mode, only markedly simplified, performing most tasks with only single keystrokes, including choosing specific files to be copied, etc. First letters of file names are often enough for *Paradox* to work with.

Databases are displayed on screen (either color or monochrome) in the form of "tables" similar to a typical spreadsheet format. Each record occupies one row, and fields are separated into columns. Columns are separated by vertical bars.

Single keystrokes move the cursor about the matrix in a manner similar to *dBASE*'s BROWSE mode, only much faster. One keystroke toggles the screen into one of several custom forms for individual record viewing and editing if you prefer, though editing can be done in the "table" screen as well by pressing F9. And, very importantly, unlike *dBASE*'s BROWSE, all changes to all records can be retracted through an "undo" command.

Reordering the display of columns, resizing columns, and rotating groups of columns is effortless, intuitive and lightning fast. Shrinking large columns down to workable size for display purposes lets you see much more data in one screen, without any data loss, and simply moving the cursor to the shrunken field and pressing a key activates a small window that can reveal all the information in this field. A key press at any time prints what's on screen for mini reports.

Aside from being very fast on screen, sophisticated virtual memory management techniques allow multiple files of almost any size to be simultaneously open, assigned a "workspace" on screen and quick-

This review is unedited. The text has been reprinted in its entirety from PC Week, November 12, 1985, ©1985 Ziff-Davis Publishing Company.

For more information and the location of the Ansa PARADOX dealer nearest you call 1-800-547-3000. Ask for Department No. 137. In Oregon or outside the U.S.A. call 1-503-684-3001.

ly searched. Disk management is handled invisibly by intelligent algorithms. Pressing the F3 or F4 key moves you rapidly up or down through successive workspaces, effectively activating the database of your choice. It's almost like magic the first time you try this.

If you're a veteran *dBASE* user, you may find the idea of having countless files open a bit unsettling, but what a relief it is. What's more, *Paradox* automatically takes care of opening and closing the appropriate indexes and keeping them up to date.

Of course, getting the data out of a database is what it's all about, either on screen or on paper, and this is where most products fall flat. Great attention to detail seems to have gone into the reporting capabilities of *Paradox*.

Data extraction in *Paradox* borrows extensively upon a technique developed by Moshe Zloof of IBM in 1975 called QBE (query by example). This technique was first made available on the IBM 360 in 1978.

QBE's basic premise is to allow the user to retrieve information from the database with only a most cursory knowledge of its inner details. The user is presented with a graphical representation of an empty record in the database which he or she fills in with data examplary of the desired results of a search. This is called a "query table" in *Paradox*.

By analyzing these entries, *Paradox* infers which information the user is looking for, and takes appropriate action, creating an "answer table" on screen to display its finding.

The user may stipulate which fields should be included in the answer table, and whether to store the answer table on disk for future use.

The same query table arrangement works for use with multiple table operations. Similar to the *dBASE III* SET RELATION TO command, multiple query tables, one for each database, may be filled in, linking several data files. The answer table can then contain information from a combination of fields of each database, for records matching all the search criteria. This is similar, though outrageously faster, than the infamous *dBASE* JOIN command. Automatic insertions and deletions from associated tables may be achieved similarly.

Imposing Constraints

A very wide variety of constraints may be imposed on data searches, including the usual mathematical operators (< > = + −), counts, averages, sums, dates and date calculations, wildcard character matching, soundex matching, string functions and others with a minimum of technical knowledge on the user's part. In most cases, the user is completely unaware of what indexes are open or how the query should be carried out.

Query tables remain active until intentionally erased, allowing fine tuning easily and quickly. In other words, no more retyping lines of cryptic code or dealing with syntax error messages.

Conducting complex queries of even a single database can call for extensive knowledge of data structures, indexes and efficient algorithms. Years of experience often go into the creation of applications with acceptable speed performance. Often, however, the result is a sacrifice in flexibility, restricting the user to limited types of data retrieval, and requiring additional programming to meet later needs. This is not the case with *Paradox*.

Paradox achieves the impossible in speed for such complex tasks as multiple joins and other complex queries by virtue of two developments from a branch of artificial-intelligence research called "machine reasoning." The developments are called program synthesis and automated problem solving.

When the user instructs *Paradox* to process a query form, the form is first translated into an executable program in *Paradox*'s Application Language (PAL), similar to the code a programmer would write. Once the program or algorithm is created, *Paradox* uses a technique called "goal-oriented problem reduction" to divide the task into subtasks and sub-subtasks, if necessary.

The tasks take into consideration such factors as existing indexes, size of relations between databases, and use of temporary data at each step of the process. If *Paradox* senses that a non-existing index file would shorten the problem-solving time, it creates one "on the fly." The technology used to achieve this is similar to that used in computerized chess games.

Once an answer table is created, it may be rearranged and printed as a report. When a simple hard copy of an answer table won't suffice, *Paradox*'s report generator certainly will.

With 115 pages of the user's guide devoted to reporting techniques, its clear the folks at Ansa heard *dBASE* user's complaints loud and clear.

Paradox's reporting system uses a screen generator with superb graphics (kudos to the programmer), which easily allow placing of fields, headers and footers, calculated fields, legends, and subtotals and totals, on the page in a variety of formats. Form letters and mailing labels are also possible. A default report format is created for you, taking much of the work out of a traditionally dreary task.

Ancillary points such as setup strings for the printer, left and right margins, lines per page, and pausing for paper change are details not overlooked. Report "pages" may be up to 2,000 characters wide, with *Paradox* handling the necessary printing on consecutive pages. Then you just tape them together.

Modification of a table's data structure automatically alters all report screen forms associated with the table to reflect the changes.

The Perks

Fringe benefits worth noting include *Paradox*'s import/export menu, which allows for use and creation of *1-2-3, Symphony, dBASE, pfs:File, VisiCalc* and ASCII files. A "Script" function will record your keystrokes (similar to *ProKey, Smartkey*, etc.) for later playback.

Certainly not to be overlooked is the speed issue. As a test, I imported a mailing list of 465 names into *Paradox* from *dBASE II* in another subdirectory on my XT. This took all of 15 seconds. Sorting on three (character) fields (multiple key sort) took another 13 seconds. In *dBASE II*, it took 2.75 minutes. This is just an example of the speed increases you can expect.

Validity checking for all types of input is also easily accomplished via a menu, at any time, even after the database is filled and structured.

In case scripting, forms files capabilities, reporting and query forms aren't enough for you, Ansa has included PAL (Paradox Application Language) with the package for applications development. This language may be used from the command line menu choice while in *Paradox*, or employed to create executable programs for later use. It is similar to the *dBASE* programming language in both name and function, but with enhancements like unlimited variables, arrays, advanced financial, trig, date and statistical functions, and DOS environment control. An integrated editor, debugger and graphical logic control simulation are included.

There are three instruction manuals available for *Paradox*, and they are intended for various levels of computer experience. All are nicely typeset, and spiral bound.

For beginners, there is an extensive tutorial, with instructions and examples included on the disks. Next, the user's guide is geared toward the experienced database user. Finally, the PAL user's guide explains the application language.

Two smaller books are geared towards *dBASE* and *1-2-3* users. Tables of contents, indexes, easy reference cards, glossaries and appendices are in evidence. The fact that I resorted to only a small fraction of the 800-plus pages of Paradox's various manuals is testimony to its ease of use. A customer support phone number is supplied and provided friendly assistance despite my anonymity.

Paradox's limitations on typical real world applications are few. A maximum file size of 256M bytes should pose no problems other than for hard-disk manufacturers. At 65,000, the number of allowable records per table (database) is identical to *dBASE II*, but less than *dBASE III*, which allows 1 billion.

At 255 permissible fields per record, *Paradox* ranks double the 128 field capacity of *dBASE III*, and eight times that of *dBASE II*. Fields may contain as many as 255 bytes each.

Unfortunately, Paradox does not have a built-in dynamically sized "memo" field for linking notes and memoranda to particular records as does *dBASE III*. Another oddity is that the number of bytes per record varies from 1,350 for indexed to 4,000 for non-indexed tables. The number of those simultaneously open is dependent upon the amount of RAM available and size of tables.

Numerical accuracy is to 15 digits, and largest number possible is 1 x 10 to the 308th power, which should be adequate for most purposes, except for balancing the national debt.

The conception that a small startup company can, at this point, break into the already saturated PC database market in hopes of stealing some thunder from the likes of Ashton-Tate and Microrim is a paradox whose truth rests on the quality of this product.

I'll hazard a guess based on my experience thus far, that *Paradox* will turn the market on its ear. ■

Robert Cowart is a freelance writer based in Berkeley, Calif. specializing in microcomputer technology and electronic music synthesis.

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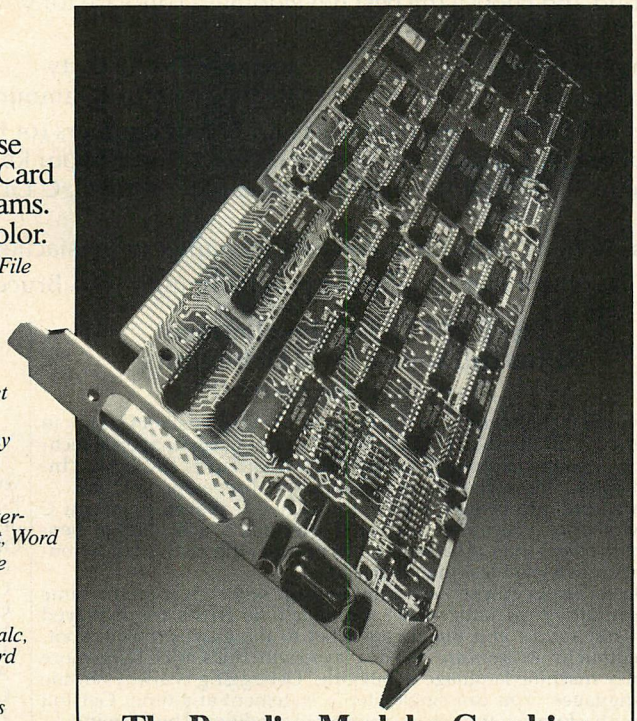
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ROBIN RODABAUGH

Accelerating 2.1

The head settle time in DOS 2.1 can be speeded up to match the faster times of versions 1.1 and 2.0.

Different versions of DOS have different values for *head settle time*. After seeking from one track to another, diskette drive heads tend to oscillate before they stabilize enough to be able to read or write data.

In DOS 1.0, the head settle time default is 25 milliseconds. For DOS 1.1 and 2.0, this default is corrected to 0, which is one reason that these later versions run faster than 1.0. Upon introducing half-height drive support in DOS 2.1, this default inflated to 15 milliseconds.

The patches presented below can reduce head settle time in 2.1. The FORMAT feature exhibits the most noticeable difference. A FORMAT of a double-sided, nine-sector diskette normally runs 65 seconds under DOS 2.1, but with the patches it takes 41 seconds.

Tests on PC*jr* and PC Portable show no problems using the faster parameters (the reason given for the increase in head settle time in DOS 2.1 was to accommodate the half-height drives of PC*jr* and the Portable).

To customize DOS 2.1 so it will run at the speed of versions 1.1 and 2.0, the reset diskette default parameters must be modified. They are contained in four locations: one in the bootstrap, two in the hidden file IBMBIO.COM, and one in the FORMAT command. The bootstrap parameters are in control momentarily at boot time. The IBMBIO.COM parameters are in control most of the time. The FORMAT.COM parameters are simply placed in the bootstrap of diskettes that are formatted; changing FORMAT.COM is a convenient way to implement the faster parameters for all diskettes to be formatted in the future, without having to run DEBUG for each one.

With the patches, all disks formatted from the customized diskette or hard disk will have the faster parameters. A hard disk must have a single partition. All disk drives have a finite head settle time. The implementation of these modifications may cause data to be sent to the disk drive before the drive is ready. Most applications successfully perform a retry not visible to the user. The critical value for the head settle time is 0. Changes up to 65 milliseconds do not significantly alter the time required to format a diskette.

To accomplish this customization, insert a double-sided boot diskette in drive A: or a hard disk in drive C:. Use DEBUG to change the head settle time defaults, as shown below. (Comments are shown in parentheses.)

These same modifications cannot be made with DOS 3.1 as the bootstrap, because IBMBIO.COM and FORMAT.COM do not have the same string of instructions that reset the diskette default parameters.

Robin Rodabaugh is vice president of computer services for a large life insurance company. He has 18 years experience with IBM mainframe and PC operating systems; he has a degree in mathematics.

FIGURE: *DEBUG Sessions to Patch 2.1*

```
FOR BOOTSTRAP:
A>DEBUG  (Run DEBUG.)
-L 100 0 0 1 (Read in the bootstrap.)
             (If patching a hard disk, use
              "L 100 2 0 1".)
-D 100       (Confirm that location 12A contains
              0F02CD19H.)
-E 12A 00    (Change 15 milliseconds to zero.)
-D 100       (Confirm that location 12A contains 00H.)
-W 100 0 0 1 (Write out the modified bootstrap.)
             (If patching a hard disk, use
              "W 100 2 0 1".)
-Q           (Exit DEBUG.)

FOR IBMBIO.COM:
A>DEBUG      (Run DEBUG.)
-L 100 0 F 1 (Read in sector 4 of IBMBIO.COM.)
             (If patching a hard disk, use
              "L 100 2 34 1".)
-D 100       (Confirm that location 177 contains
              0F9C1E50H.)
-E 177 00    (Change 15 milliseconds to zero.)
-D 100       (Confirm that location 177 contains
              00H.)
-W 100 0 F 1 (Write out sector 4 of IBMBIO.COM.)
             (If patching a hard disk, use
              "W 100 2 34 1".)
-L 100 0 10 1 (Read in sector 5 of IBMBIO.COM.)
              (If patching a hard disk, use
               "L 100 2 35 1".)
-D 100        (Confirm that location 154 contains
               0FABB002H.)
-E 154 00     (Change 15 milliseconds to zero.)
-D 100        (Confirm that location 154 contains
               00H.)
-W 100 0 10 1 (Write out sector 5 of IBMBIO.COM.)
              (If patching a hard disk, use
               "W 100 2 35 1".)
-Q            (Exit DEBUG.)

FOR FORMAT.COM:
A>DEBUG  (Run DEBUG.)
-N FORMAT.COM (Name FORMAT.COM as the target file.)
-L            (Read in FORMAT.COM.)
-D 1A00       (Confirm that location 1A22 contains
               0F02CD19H.)
-E 1A22 00    (Change 15 milliseconds to zero.)
-D 1A00       (Confirm that location 1A22 contains
               00H.)
-W            (Write out the modified FORMAT.COM.)
-Q            (Exit DEBUG.)
```

These sessions show the sequence of commands for the modifications to the bootstrap, IBMBIO.COM, and FORMAT.COM.

DAN DAETWYLER

Ensuring Data Integrity

The techniques for the generation of duplicate file handles outlined here can protect against loss of data in RAM.

Power surges can cause severe problems if they occur while a data file is being created. After the system is rebooted, the user discovers that all data in RAM were lost and all open files were left open.

Consider, as an example, an order entry application, which is made up of customer files, inventory files, and order files, and which supports a number of access paths, or indexes, to those files. All of the system activity is related in some way to access of the database, and, as a result, all primary files are opened when the system is booted. Further, all of these files remain open until the end of operations.

A large number of buffers assigned in the CONFIG.SYS file can produce performance advantages for multi-file processing applications running in DOS, such as the order entry example that was mentioned above. However, even when only the minimum number of buffers is assigned, DOS writes data back to disk only when the data required are not already stored in RAM and when no empty buffers are available. Consequently, an increase in the number of buffers that are assigned in the CONFIG.SYS file simply increases the amount of data that are stored in volatile memory.

When a new customer record is added to the order entry file in the example, the indexes are updated for the customer file, an entry is added automatically to the order file, and, finally, the index of the order file also is updated. However, this new information is not written back immediately to the actual file; instead, DOS retains it in memory buffers. Similarly, if the addition of this record has forced the allocation of a new cluster, this information is stored only in the memory-resident FAT, not on disk. Neither the size nor the content of the actual file is altered.

If a break in power occurs before all of the new data are written to the disk, they, along with any other data stored only in the memory buffers, are lost.

Data are passed from buffer to disk either when a buffer is required for new data or when DOS flushes all the buffers at the request of the user. A flush of all the buffers can be accomplished with function call 00H (program terminate) or function call 0DH (disk reset). The buffers for a specific file can be flushed with function call 10H (close file) or function call 3EH (close a file handle).

Suppose a new customer record is added in the order entry file that forces the allocation of a new cluster. Updates are made in the FAT, and, as the result of subsequent I/O, are forced out to disk. The new record also may be written to the disk; however, the key in this case is not the record but the directory. If the file is not closed and a break in power occurs, the directory may not be written back to disk.

When the system is rebooted, both an incorrect FAT and directory exists for that open file. The FAT points to a record that is outside the allocation of the master file. The record may have been written, but when the user attempts to access it an I/O failure occurs. The FAT says the record is present, but the file is unable to locate it. If the FAT made it to disk before the break in power, a CHKDSK with the /F parameter in DOS will correct the problem. This, however, can be discovered only through trial and error.

This kind of problem is inherent in any on-line system environment. Each separate applications system, or short job, within the environment remains in the memory buffer only as long as actual processing is taking place, and file integrity is fully restored each time that the file is closed. However, in such an environment, database files typically are not closed until the termination of the entire system at the end of each day. As a result, the data stored in memory buffers remain unprotected and vulnerable until closure of database files.

One solution to this problem is to close a file immediately after it has been updated. This, however, necessitates reopening the file for each use. DOS is reasonably quick when closing a file, but can be excruciatingly slow when opening one because of the directory search it must perform in order to find the file to be opened.

Another solution that reduces the chances of data loss involves generating duplicate file handles using INT 45H (mnemonic DUP). DOS maintains the file control block (FCB) in memory and provides a handle that can be used to read, write, or close a file. DUP provides that, when an existing handle is placed in the BX register and a call is made, DOS returns a duplicate handle for that file in the AX register.

Each time that a file is updated, the user can create a duplicate file handle and use it to close the file. The records, the FAT, and the directory entry for that file are all written from memory safely back to disk. Moreover, the user does not need to reopen the file after the file information has been forced out to disk because the original file with the original file handle is already open—it was never closed. The seek pointer for this original file has remained intact.

Detecting the state of the buffers for a program under execution on a PC is difficult. However, if a compiler uses DOS calls and file handles, this technique works as outlined. Unfortunately, most compilers currently use FCBs to the exclusion of file handles; they are intended for use with DOS versions 2.0 and earlier, which do not employ file handles.

This method of data protection is not foolproof. Data still can be lost in the interval existing between the start of a file update and the pseudo file close.

Dan Daetwyler, now retired, worked for 20 years as a systems architect with IBM. He received his bachelor of science degree in physics from Kansas State University at Pittsburgh, Kansas.

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CIRCLE 116 ON READER SERVICE CARD

ERIC M. MILLER

Elusive Acquisition

Some high-frequency AC signals are difficult to capture with a data acquisition board; the circuit discussed here helps to provide a solution.

A data acquisition board can work great when measuring DC or low frequency AC signals. But what happens when it is needed to measure AC amplitude at frequencies of as high as 500 KHz? The sampling frequency of several million samples per second cannot be obtained directly. The signal preconditioning circuit described here is one method of overcoming this problem.

This circuit determines the RMS value of the AC waveform and converts it to a DC voltage that can be handled by the analog input channel on the data acquisition board. (Remember, not all AC waveforms are sinusoidal.) The root mean square converter calculates the equivalent DC voltage for the AC input. This voltage is derived from the square root of the mean of the square of the supplied AC voltage.

The figure shows one way to achieve this. Switch S1 permits a choice of AC or DC coupling. Diodes D1 and D2 and resistor R3 provide input amplifier protection. U1 is a National Semiconductor LF411, selected for its bandwidth and low input bias current. The offset voltage may be adjusted to near zero by the variable resistor Rvos. Switch S2 permits operating U1 as a buffer or a gain stage.

Note that R2 sets overall circuit gain. The values shown yield a gain of 10. High voltages (greater than 10v RMS) can be handled by an input attenuator, or by configuring U1 in an inverting amplifier mode with fractional gain.

The output of U1 drives an Analog Devices AD536A TRMS (True Root Mean Square) converter. The values shown give low ripple down to 60 Hz. Capacitors Cav, C2, and C3 must be increased for lower frequencies to keep the ripple voltage to a manageable size. The output of the 536A can directly drive an analog input on a data acquisition board. Set this analog channel for a range of 0 to 10 volts.

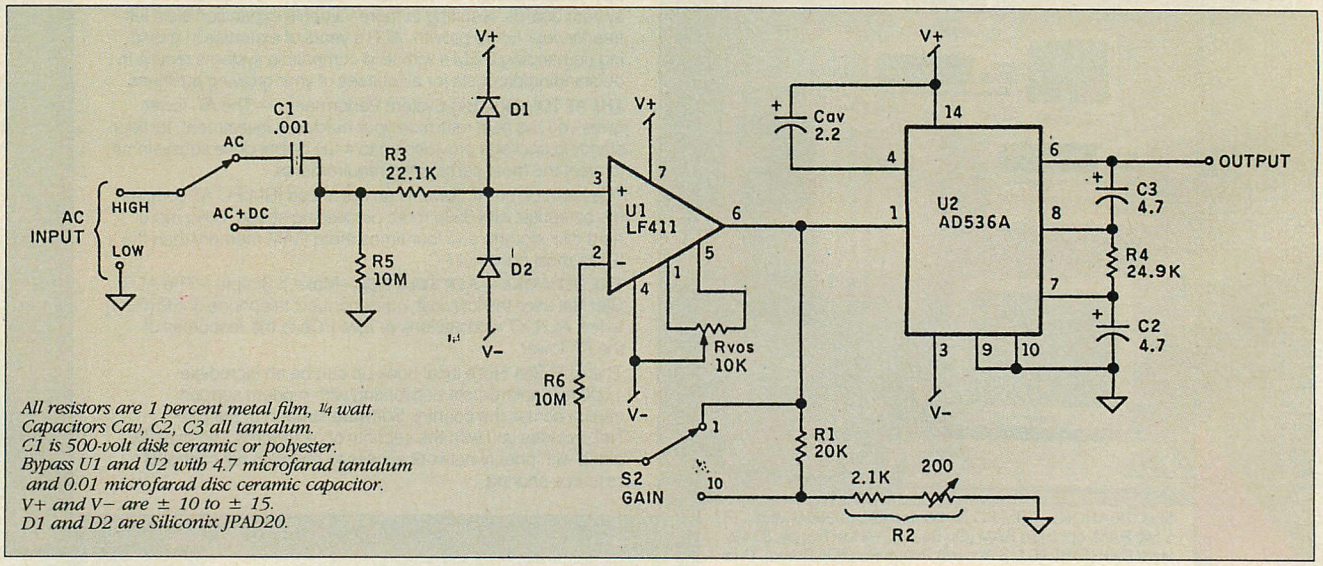
The circuit's gain and offset may be adjusted by first shorting the input and adjusting Rvos for zero output. Next, the gain can be trimmed by applying a known amplitude 1 KHz signal to the input, and adjusting R2 until the output gives the correct TRMS voltage.

Remember that a circuit such as this should not be connected directly to the AC power line because 99 percent of all data acquisition cards do not isolate their inputs from the computer's ground. A method of measuring the power line voltage would be to use an isolation transformer such as a 6.3-volt filament transformer.

AC current measurement can be done using a current probe in a typical fashion; simply connect the probe to the input of the preconditioning circuit.

Eric M. Miller is president of Miller Technology, Inc., a firm that specializes in analog-to-digital hardware/software systems. He earned a master's degree in electrical engineering from Purdue University.

FIGURE: *Signal Preconditioning Circuit*



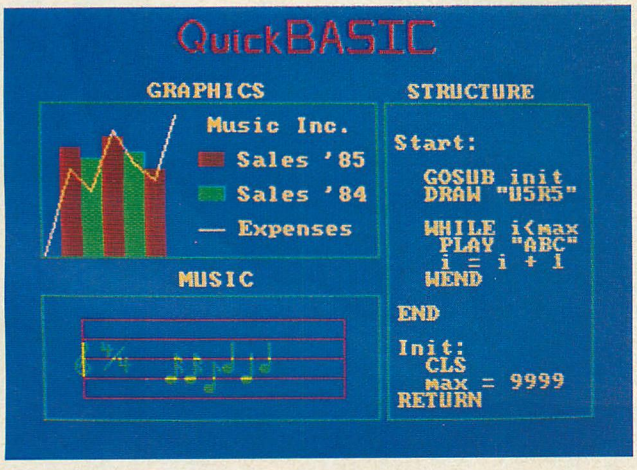
This preconditioning circuit enables AC voltage waveforms outside the specified range of the data acquisition board to be analyzed by first converting the waveform to its DC equivalent and then injecting this equivalent waveform into the board.

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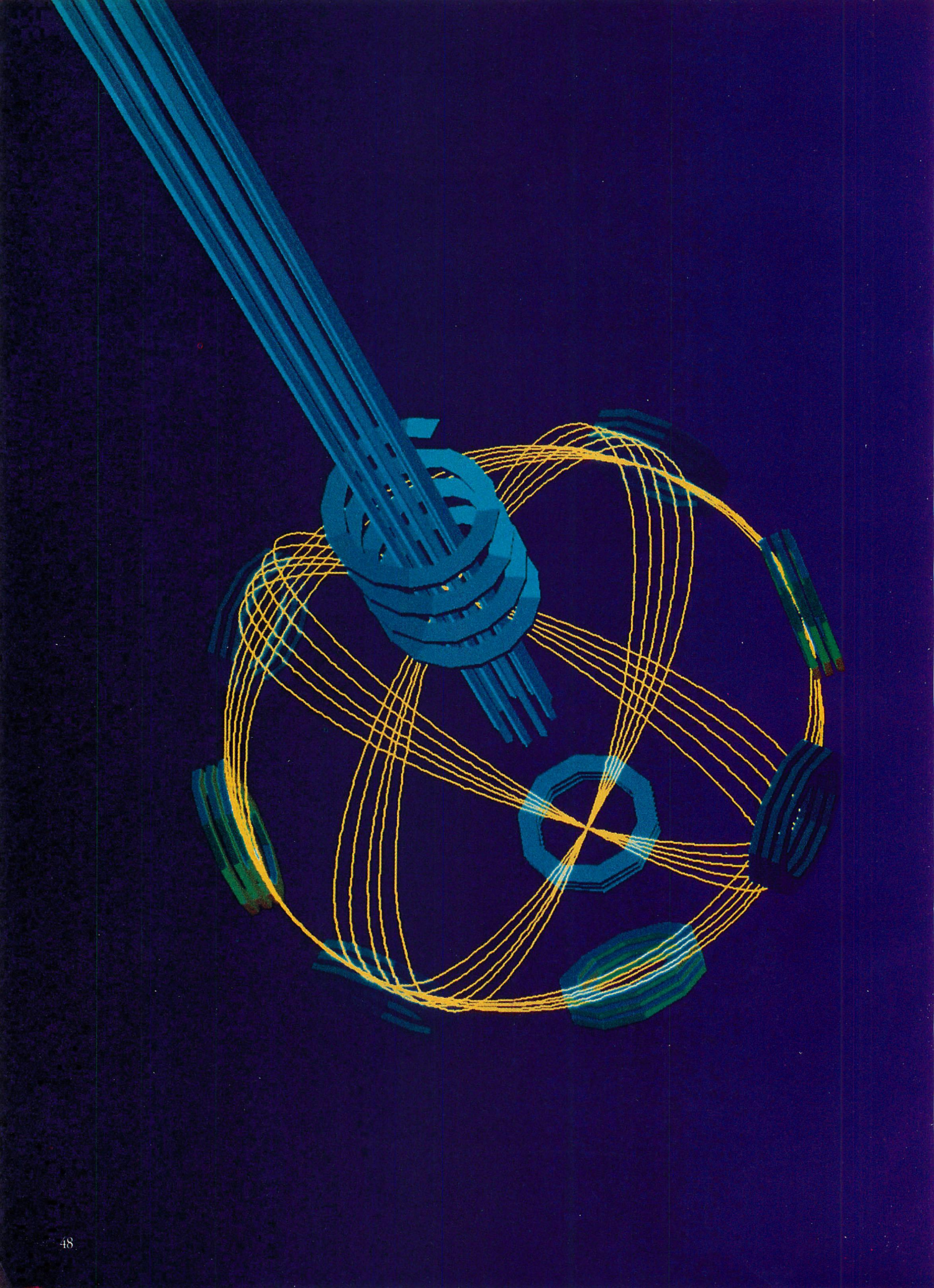
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Multitasking Methods

The PC family now has the power to handle multitasking systems with realtime applications. This series of articles begins with a look at minimal multitasking packages that coexist with DOS.

RICHARD M. FOARD

This is the first in a series of articles about multitasking operating systems that can be used in realtime applications. The series begins with a discussion of multitasking basics, an example of multitasking in its simplest form, and a review of a commercial subroutine package for PC multitasking. Proceeding from the plain to the fancy, subsequent articles will review commercial multitasking environments, first examining cooperating systems that run under DOS, then presenting a number of full-fledged, stand-alone multitasking operating systems. Products examined will be limited to those useful to developers building PC-based realtime or transaction processing systems.

Since the dawn of computing, computers have been doomed to deal with objects much slower than they are. Even the earliest computers swallowed and spat data faster than the printers, card readers, tape drives, and disks that surrounded them. Because nearly all programs needed to use inherently slow input and output devices, the fabulously expensive new computing machines often spent more time idling than they spent computing.

The obvious solution to the problem—running several programs concurrently so that when one had to wait for something, another could do useful work—first appeared in the 1960s in the form of *multiprogramming*, or

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batch, operating systems for mainframe computers. These load and run many programs at once, creating the appearance that each had a machine to itself.

As computers were put to new tasks, the techniques used in batch operating systems found application in other settings. The first time-sharing systems were multiprogramming systems like their batch predecessors, but met the additional requirements of responsiveness and fairness. A batch system made efficient use of machine resources, while time-sharing systems went one step further to ensure that no individual program waited too long for its turn at the processor.

Transaction processing systems, such as the pioneering SABRE airline reservation system, emerged and, like time-sharing systems, had to perform many functions concurrently while providing timely service to many users. They also brought with them another layer of requirements. Whereas the programs on time-sharing computers were independent competitors for processor time, the programs making up transaction processing systems had additional responsibilities to perform. They needed to cooperate with each other to pass information back and forth, manage a shared database, and retain enough checkpointing information to enable quick, reliable failure recovery.

Another area in which concurrent processing techniques were put to use was realtime systems. Characterized by an ability to respond quickly to events occurring outside the computer, realtime systems found application in industrial instruments, process control systems, military weapons systems, and scientific data-gathering equipment. Realtime systems, such as those for the space flight program, met some of the most demanding requirements for concurrent processing ever devised.

In the mid-1980s all these types of applications are converging on the PC and shouldering their places among the spreadsheets and word processors. One PC now packs enough power to serve several users simultaneously in most applications. As well as having come of age as a small time-sharing engine, the PC has evolved into a serviceable hardware foundation for a large class of realtime and transaction processing systems. The IBM PC family has the processing power, memory, devices, and I/O structure that are required in the lower end of concurrent processing applications areas such as process control, robotics, transaction processing, and communications switching.

The last four years have seen the base of business software for the PC grow from a few rudimentary BASIC programs into an enormous array of sophisticated products that exploit the machine to its limits. A similar explosion is now under way in the smaller marketplace of realtime and transaction processing systems, and it is gathering momentum as more supporting software and hardware become available to product developers.

MULTITASKING BASICS

The term *operating system* has come to encompass all the systems software that stands between an applications program and the resources of its underlying machine and I/O devices. A multitasking environment need not be an operating system in this sense of the term. It can, in fact, be realized in a small set of subroutines. Strictly speaking, a software package creates a multitasking environment if it provides context switching and task scheduling.

In order to allow the construction of tasks as separate, sequential programs even though they run concurrently, a multitasking environment must provide each task with a *context*—a view of its own state (program counter, local and global storage) and the processor's state (registers, flags, etc.), which remains undisturbed while other tasks run. By switching rapidly from one context to another as it shares the processor's time among tasks, the environment creates for each task the illusion that it has a machine to itself. This illusion distinguishes multitasking from other forms of concurrent processing such as interrupt-driven applications, which process any given task based on the interrupts that are received.

As well as having come of age as a small time-sharing engine, the PC has evolved into a serviceable hardware foundation for a large class of realtime and transaction processing systems.

Concurrent programs oblivious of each other's activities are called *asynchronous*. The ability to run concurrent, asynchronous tasks allows a system designer to decompose a problem in which ten tasks must be done concurrently into ten simple, sequential programs instead of just one complex, state-driven program that has built-in knowledge of how to perform all ten jobs in parallel. The cost of the approach is execution overhead; the time the processor spends in context switching is time it is not spending getting the ultimate job done. Benefits of the multitasking model of concurrent processing accrue because it reduces software complexity. They are manifested in reduced design and development costs and increased system reliability.

A multitasking environment's scheduling discipline is the mechanism by which it determines when each task is allowed to run and for how long. Scheduling disciplines range from simple ones in which each task runs until it explicitly surrenders control of the processor to complex ones under which the environment chooses which task to run next using a priority system and interrupts tasks when they exceed a limit on running time or when a higher priority task is ready to run.

Outside a time-sharing setting in which many independent users compete for a single processor, a multitasking system rarely consists of tasks that are entirely asynchronous. The technique of multitasking is far more frequently applied where tasks must cooperate to share scarce resources and pass information back and forth. As a consequence, most multitasking environments, even minimal ones, provide a way for tasks to forego asynchronous operation temporarily and synchronize with each other.

Synchronization comes into play when a task needs or chooses to wait for something outside its control to happen before proceeding. For example, a task might require input from a peripheral device, a message from another task, or permission to use a system resource (perhaps a printer) that can serve only one task at a time. The environment must have some means of taking control so that it can allow other tasks to run while some wait. It must also provide the tasks with a way to signal others that an event has occurred that they might be waiting for.

All but the leanest of multitasking packages offer more than the bare essentials of context management, scheduling, and synchronization. Most provide functions addressing common higher-level needs of multitasking system architects. The need for intertask-

ing data queues, for example, is almost universal in multitasking applications, and consequently many packages include synchronized queue management facilities. Timing is another common necessity. Facilities often are provided that allow tasks to "sleep" for specified periods of time or to set watchdog timers so that they can detect device failures. Many products incorporate interrupt handling routines for frequently used devices, such as the system keyboard and serial communications ports, external terminals, and printers.

LIVING WITH DOS

The two multitasking packages examined in this article—CX/PC from INTRSoft Company and TJ/OS, a multitasking toolkit assembled by the author—fall in the category of cooperating systems, so called because they coexist with DOS. Both are subroutine packages that are linked to the user's applications program and can be called upon to establish and operate a multitasking environment atop DOS.

Because DOS itself was not built as a multitasking operating system, it lacks a property that is essential in any software serving multiple tasks: the ability to be shared. A piece of code can be shared if it can be called upon freely by asynchronously executing tasks.

One way to create code that can be shared is by making it reentrant. Programmers create reentrant code by constructing it to maintain all its local storage within a task's context (usually the processor's registers and the stack). If the placement of local storage is thus restricted, a section of code can operate correctly even when several tasks are concurrently active within it.

A weaker form of sharing can be achieved in code that is not strictly reentrant by equipping it with a mechanism that guarantees that, although many tasks may enter the code, only one at a time can proceed through its nonreentrant sections. Code constructed with such gatekeeping mechanisms is described as *serially reusable*.

DOS is neither reentrant nor serially reusable. It operates correctly only if allowed to complete the processing of a function call and return control to the caller before undertaking the processing of another. If multiple tasks were allowed to call DOS freely, disaster would strike. Because DOS has only one set of local storage, the first time a task called DOS while its local storage held the state of a previous caller, the previous caller's state would be overwritten and lost. System failure would occur when the first caller tried to proceed with its now-inappropriate state information. A task that had called DOS to open a disk file, for example, might erroneously return from DOS to another task's routine that had just called DOS to print a line on the printer.

The two packages discussed below take an effective but wasteful approach to avoiding problems arising from DOS's non-reentrancy. They incorporate simplistic task scheduling disciplines that are incapable of switching task contexts while a DOS operation is in progress. Both packages can switch contexts only when explicitly called on by a running task to do so; because a task cannot call both DOS and the multitasking package at the same time, a second task does not have an opportunity to enter DOS before the first has left.

Coexisting with DOS is a mixed blessing. On the positive side, the scheme is easy to implement and allows the multitasking application the use of DOS's substantial facilities, including its file system and device drivers. The price to pay for this is reduced system throughput and balky realtime response when tasks call DOS. Future articles in this series will examine cooperating systems that push DOS a little closer to its limits by permitting context switches during DOS operations.

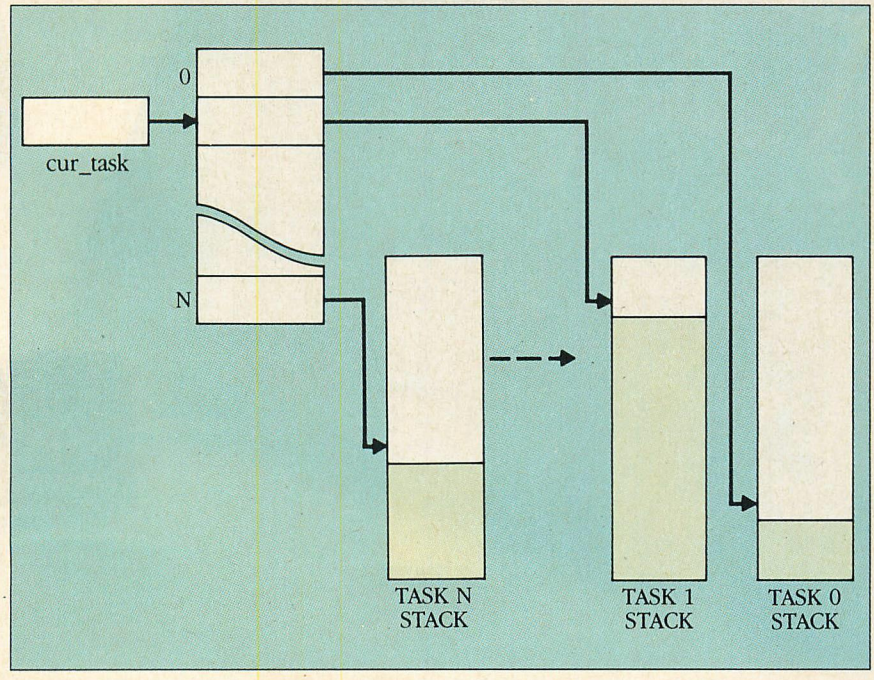
TJ/OS (Tech Journal co-Operating System) is a multitasking toolkit assem-

TABLE 1: *TJ/OS Routines*

SUBROUTINE	FUNCTION
init_os( )	Prepares the TJ/OS environment
int fork(stack, stack_size) char *stack; int stack_size;	Creates and activates a task
yield( )	Allows context switching
stop( )	Deactivates a task
wait (event_counter) int *event_counter;	Waits for an event
post (event_counter) int *event_counter;	Signals that an event has occurred

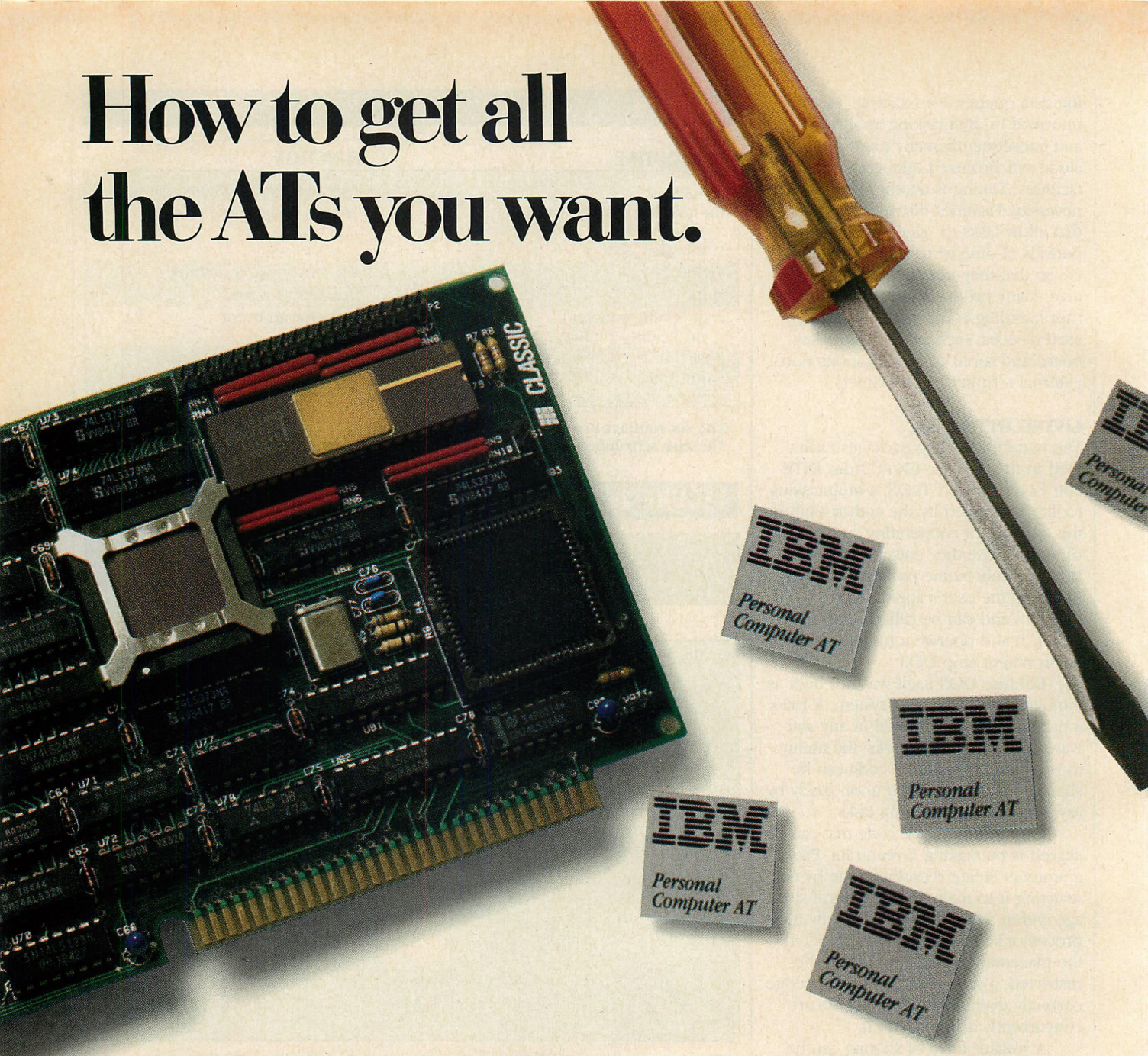
The six routines used by TJ/OS provide the basis for a realtime operating system. The task scheduling is nonprioritized, and each task is served on a first-come basis.

FIGURE 1: *TJ/OS Environment*



The data structures of TJ/OS are task_tbl, cur_task, and actv_task. Cur_task contains the index of the currently active task's entry in the task table.

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bled by the author to illustrate the minimum level of multitasking support. The goals in constructing TJ/OS were to provide true multitasking, to support applications written in a high-level language (Microsoft C), and to do as little programming work as possible in the process. TJ/OS consists of six C-callable subroutines, summarized in table 1 and shown in listing 1.

The Microsoft C runtime environment, like most PC language environments, maintains a single stack on which a program's local storage is allocated and in which its subroutine return addresses are stored. TJ/OS extends this environment by maintaining a stack for every active task. The structure of this environment is shown in figure 1. Its only permanent data structures are a table of active tasks (**task_tbl**), a variable (**cur_task**) that holds the index of the currently active task's entry in the task table, and a count of the number of active tasks (**actv_tasks**).

TJ/OS's scheduling discipline is egalitarian and cooperative. Tasks pass control from one to another like relay runners pass the baton. A task continues to run until it calls the scheduling and context-switching routine **yield**, which saves its context by pushing the BP (frame pointer) register onto the stack and storing the current stack pointer in the task table. The scheduler then switches to a new context by scanning the task table in round-robin order for the next active task, installing the new task's stack pointer, and executing a return instruction to transfer control to the new task. A task continues to participate in this rotation until it elects to deactivate itself by calling **stop**. (Control is returned to DOS if the only remaining active task calls **stop**.)

When saving a task's context, TJ/OS preserves only the registers BP and SP, which must be preserved across a subroutine call in the Microsoft C (small memory model) environment. TJ/OS can ignore other registers because its scheduling discipline guarantees that it will save and restore a task's context at times when compiler-generated code does not depend on the register's contents being preserved. (If an assembly language subroutine calls **yield**, it is responsible for saving and restoring any other registers it depends on maintaining across the call.)

TJ/OS, which is designed to be used with version 3.0 or later of the Microsoft C compiler, must engage in subterfuge to coax the C environment into working with more than one stack. Compiler-generated code for subroutines begins with a call to the routine **chkstk**, which allocates space for the routine's local storage on the stack after verifying that the stack will not overflow. Because the standard C runtime environment operates on the assumption that a program has just one stack, **chkstk**'s overflow test will not work properly in the presence of TJ/OS's stack-switching. TJ/OS ducks the problem by supplying its own version of **chkstk** that replaces the standard routine when a program is linked. TJ/OS's version forgoes the overflow test and simply adjusts the stack pointer to allocate the required space.

Under many multitasking environments, a programmer must ensure that any subroutine that can be called from more than one task (including those in the compiler's runtime library) is reentrant. Under TJ/OS, this is not a concern for the same reason that DOS's non-reentrancy is not a problem—the task scheduler is never given an opportunity to switch contexts during the execution of routines that do not call **yield**. Only routines that call **yield** or that are used by both interrupt handlers and tasks must be reentrant.

TJ/OS, which is designed to be used with version 3.0 or later of the Microsoft C compiler, must engage in subterfuge to coax the C environment into working with more than one stack.

To prepare the TJ/OS environment for use, a multitasking program calls **init_os**, which initializes the task table and sets **cur_task**, identifying the program's initial (linker/loader-established) stack as the first task's context. The multitasking environment is ready and operating with one active task at the time that control returns from **init_os** to the calling program.

Once the TJ/OS environment has been prepared, tasks can create as many other tasks as the task table will accommodate. Tasks are started in UNIX style, by calling the routine **fork**; the caller passes an array that becomes the new task's stack (stack and data segments must be identical). **Fork** creates an entry in the task table for the new task, sets its stack image up to cause it to appear to return from **fork**, then returns **false** to the original task. When the newly created task receives its first chance to run, it begins executing at a point in the code immediately following the **fork** call, but sees a return value of **true** from **fork** where the task that started it saw **false**. By testing their respective return values, the two tasks can branch into different execution paths.

Because **fork** slips another stack into the C runtime environment somewhat underhandedly, a newly created task must obey one unnatural rule. It must not attempt to reference the formal parameters or local variables of the procedure containing the **fork** call that created it, because these variables are defined only in the creating task's stack. For similar reasons, a subroutine in the creating task may not pass parameters to one in the created task. In light of these restrictions, TJ/OS tasks are usually spawned using a statement like:

```
if (fork(stack, stack_size)) newtask();
```

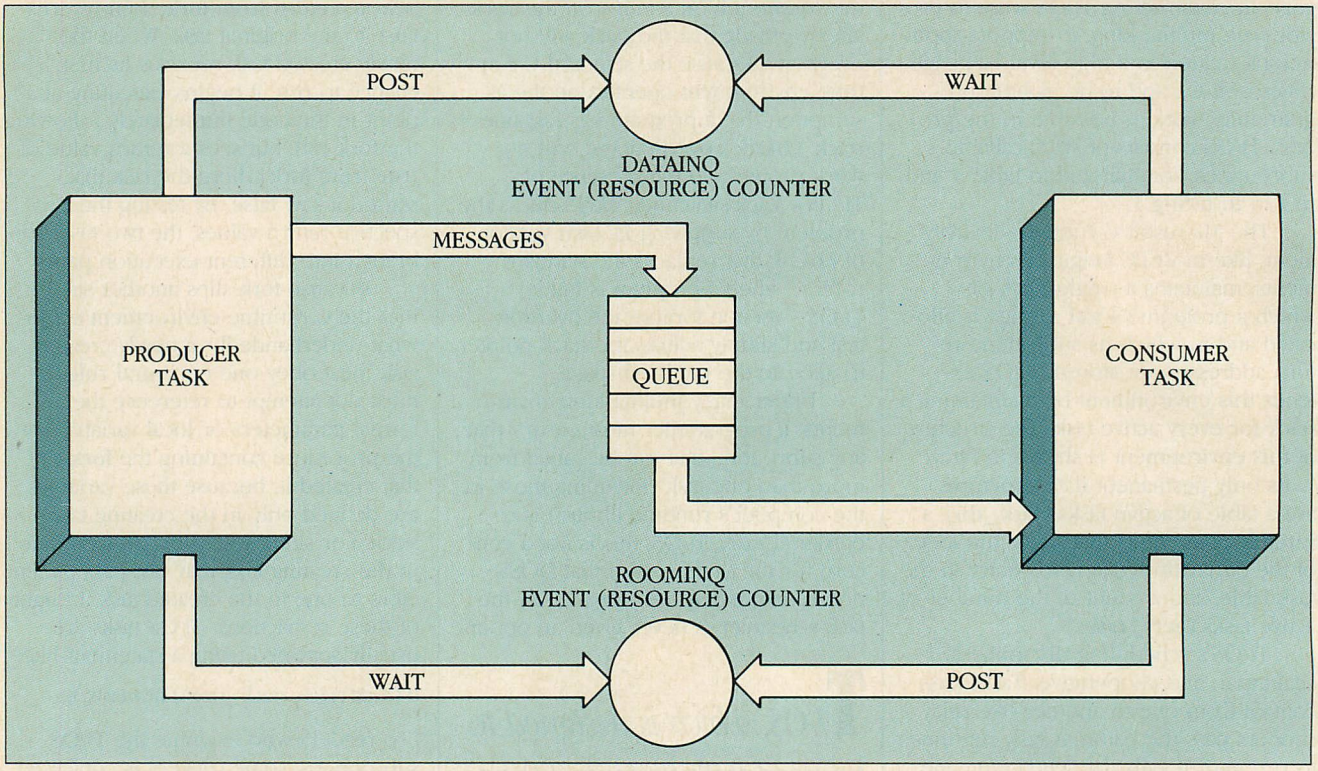
(To readers who examine the TJ/OS subroutines, some trickery is confessed in the matter of **fork** returning the value **true** to the new task. **Fork** relies on the **yield** routine to start the new task at a later time by finding its table entry, installing its context, and executing a return instruction. Because **yield** always returns **true**—its return value is ignored by tasks that call it normally—it appears to the new task that it is **fork**, not **yield**, that returns it the value.)

Because TJ/OS has no way of interrupting, or preempting, a running task, the environment works properly only if the tasks under its control cooperate. A task that loops in an execution path without a call to **yield** will retain control of the environment forever; its greedy behavior ends multitasking abruptly and permanently.

Tasks also must be designed to ensure that realtime response requirements are met. In a system in which one task must guarantee a response to some input event within 200 milliseconds, for example, the designer must ensure that the execution paths of all other tasks that might run between the time the event occurs and the time the limit expires consume no more than 200 milliseconds. In such cases, the price of TJ/OS's simplicity in scheduling is paid by the system designer in design and tuning headaches.

To meet realtime response requirements a designer must be satisfied that the processor is not being asked too

FIGURE 2: *Producer/Consumer Relationship Diagram*



In a producer/consumer relationship, each task must run only when another task has completed a particular function. Both tasks can have the same priority, but each will run only when the relevant event counter has a value greater than zero.

much; multitasking does not magically extend a computer's processing power. The designer also must observe a rule that is easy to state but almost impossible to follow strictly: if a task must respond to an external event within a fixed amount of time, then all the system's other tasks must be constructed so that the combined execution times of their longest stretches of instructions between **yield** calls is less than the fixed time limit. The rule embodies the worst-case assumption that, when the external event occurs, the task that is responsible for responding has just given up its turn at the processor and, furthermore, that all the other tasks lie in a state requiring that they traverse their most time-consuming execution paths before calling **yield**.

Short of counting instructions and adding up microseconds, designers can do very little to be absolutely certain that a system will comply with this rule the first time it is turned on. In practice, designers typically rely on intuition and follow some general guidelines in building a system, then run it under stressful realtime conditions so that they can observe its response characteristics and tune it up where it falls short.

The single most important guideline is that no task should execute too long between calls to **yield**; *too long* is an application-dependent length of time. In many cases a natural point exists at which tasks should yield control. In a task consisting of a simple endless loop, a single call to **yield** usually can be coded on a path that is executed each trip through the loop. Tasks that perform bigger, meatier computations such as floating-point data reductions may require that **yield** calls be placed here and there amidst the computations so that the task does not tie up the processor for too long at one time. In the presence of processor-intensive requirements such as these, system tuning becomes a cut-and-try activity. The designer makes trial runs of the system and, based on observations of its behavior, breaks up lengthy computations until the desired responsiveness is achieved for all system inputs.

If an experimental approach to tuning does not work, the developer can resort to more analytical methods. The **yield** routine, for example, can be made to capture in unused memory a history of recent context switches, time-stamping each entry with a copy of the system's realtime clock value. Careful analysis of the resulting voluminous raw data points to tasks that are taking processor time in excessive gulps if the system's clock resolution is sufficiently fine. A designer who must work this hard to tune a system is probably asking too much from a nonpreemptive scheduling discipline and should consider switching to a priority-based scheduler that provides a simple, direct way to ensure that the time-critical tasks render timely responses.

Like its scheduling discipline, TJ/OS's **wait** and **post** synchronization primitives offer simplicity at the expense of some power and generality. **Wait** and **post** operate on 16-bit quantities called *event counters*. Applications systems associate event counters with anything a task might have to wait for: the occurrence of an interrupt, for example, the presence of a message in a data queue, or the use of a nonreentrant subroutine.

An event counter value of 0 indicates that the counter's associated event has not yet occurred or that no units of its associated resource are currently available. Tasks that execute a **wait** call on a counter with value 0 are prevented from leaving the **wait** routine until its value becomes positive. Executing a **wait** for an event whose counter value is positive results in the value of the counter being reduced by 1 and the waiting task being allowed to proceed.

FIGURE 3: *Producer/Consumer Relationship*

```
#define QUEUESIZE 16

  static char   msgqueue[QUEUESIZE]; /* inter-task */
                                     /* message queue */
  static int    nextin, nextout;

  static int    roominq, datainq;    /* event counters */

  static char   cons_stack[1024];    /* consumer task's stack */


main()
{
    /* start the TJ/OS environment */
        init_os();

    /* initialize the message queue and */
    /* its associated event counters */
        nextin = nextout = 0;
        roominq = QUEUESIZE;
        datainq = 0;

    /* start the consumer task, then */
    /* assume the role of producer task */
        if (fork(cons_stack, 1024)) cons_task();

        prod_task();
}
```

```
prod_task()
{
        char    msg;

    /* repeatedly send the alphabet to the consumer task */
        for (;;) { /* repeat forever */
            for (msg = 'A'; msg <= 'Z'; ++msg) {
                wait(&roominq);
                msgqueue[nextin] = msg;
                nextin = (nextin + 1) % QUEUESIZE;
                post(&datainq);
                yield();
            }
        }
}


cons_task()
{
        char    msg;

    /* dequeue messages from the producer */
        for (;;) { /* repeat forever */
            wait(&datainq);
            msg = msgqueue[nextout];
            nextout = (nextout + 1) % QUEUESIZE;
            post(&roominq);
            yield();
        }
}
```

Event counters are used with the TJ/OS subroutines to enable a task to recognize that an event has occurred. The first task posts an event count and then yields, allowing the second task to act on the information generated by the first task.

The logic of the **wait** routine (paraphrased in C) is simply

```
wait(event_counter) {
    while (*event_counter == 0) yield();
    *event_counter = *event_counter-1;
}
```

Wait depends on the fact that TJ/OS's task scheduler knows no difference between active tasks that are waiting and those that are not. **Yield** gives each task a chance to run every time it goes through the task table.

Wait's counterpart, **post**, is called by a task to indicate that an event counter's associated event has occurred or that a unit of its associated resource has become available. A **post** operation on an event counter is accomplished by incrementing the counter:

```
post(event_counter) {
    ++(*event_counter);
}
```

A simple example of two synchronized TJ/OS tasks in a producer/consumer relationship is in figures 2 and 3.

Interrupt handlers for a TJ/OS-based application are written the same way as interrupt handlers for DOS programs. They must save registers, process and dismiss the interrupt, restore registers, and execute an IRET instruction. Interrupt processors may communicate with tasks using **post**. They may not call **wait** or **yield**, however, because they run outside the context of any task. TJ/OS runs all tasks at equal priority and does not preempt running tasks, so the receipt and processing of interrupts has no effect on task scheduling, even when an interrupt handler posts events for which the tasks are waiting.

Because many tasks can wait for the same resource, **wait** must be an indivisible operation so that two tasks cannot erroneously consume the same event or resource by testing the value of the event counter before either decrements it to 0. **Wait**'s indivisibility with respect to other tasks is ensured in the TJ/OS environment by the absence of a call to **yield** on the execution path between the **while** statement's test of a positive event counter and the assignment statement that decrements the counter. Because task scheduling is nonpreemptive, a task that begins executing the **while** statement's test will finish executing the assignment statement and leave **wait** before any other task can execute the **while** test.

Wait is not indivisible with respect to interrupt handling routines, however, and it contains one critical section of code that must be protected from interruption (this protection is not shown in the foregoing C paraphrase of its logic). In its assembly language implementation, **wait** loads the contents of the event counter into a register to test its value; if the counter is positive, the register is decremented and its contents stored back into the event counter. Interrupt processing routines must be prevented from posting an event counter while **wait** is holding the counter's value in a register for inspection, so the **post** is not lost when **wait** stores the register back into the counter. **Wait** protects itself by disabling interrupts during this sequence of instructions.

TJ/OS's simple synchronizers are like a compass and straightedge in the hands of a draftsman. They can be used to construct nearly anything, but not without improvisation. Before moving from TJ/OS to packages richer in function, this article will look briefly at one example of a design predicament that requires some work above the level of TJ/OS's primitives to solve.

TJ/OS's event counters are poor relations of the more powerful semaphore synchronizers. Under semaphore-based synchronization, tasks that wait for an exhausted resource are automatically placed in a FIFO queue and, as resources become available, allowed to



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proceed. TJ/OS tasks are not as well-behaved. Instead of lining up in a queue, they form a disorderly mob. When the resource becomes available, whichever waiting task runs first consumes the resource and proceeds. As discussed earlier, the tasks are selected in round-robin order. Each time a task yields, the next task in order is taken. If this requires the available resource, it will take it regardless of whether other tasks have been waiting longer.

Mobbing can be undesirable when a resource must be shared fairly among competing tasks. Using event counters, two tasks can be made to consume a stream of events in strict alternation by introducing a *permission to wait* event counter for each task and coding each task to wait first for its own permission counter, then for the event's counter, and then to post the other task's permission counter (figure 4). Two tasks that consume a stream of events in an equally fair but slightly more relaxed sequence are shown on the right in figure 4. Each task has an associated event counter (**count_1** and **count_2**, respectively) that is initially set to zero. The first task is allowed to run because **count_1** is not greater than **count_2**. The task runs, then it increments the event counter by one before yielding. The second task is allowed to run because **count_2** is now not greater than **count_1**. It in turn increments its event counter, **count_2**, before yielding, which allows task one to run again.

TJ/OS is a simple, priority-less, nonpreemptive multitasking package. It provides for the dynamic creation and destruction of tasks and supports a simple but well-structured form of intertasking synchronization. In the hands of a programmer experienced in concurrent processing and willing to undertake applications-level solutions to timing and synchronization problems, TJ/OS can serve as a base for small, useful multitasking systems.

FIGURE 4: *Queuing vs. Mobbing, Two Versions*

```
        (initialization)
              .
              .
        permit_1 = 1;
        permit_2 = 0;
              .
              .


task_1()
{
        for (;;) {
            wait(&permit_1);
            wait(&event);
                .
            /* process event */
                .
            post(&permit_2);
            yield();
        }
}


task_2()
{
        for (;;) {
            wait(&permit_2);
            wait(&event);
                .
            /* process event */
                .
            post(&permit_1);
            yield();
        }
}
```

```
        (initialization)
              .
              .
        count_1 = 0;
        count_2 = 0;
              .
              .


task_1()
{
        for (;;) {
            while (count_1 > count_2) yield();
            wait(&event);
            ++count_1;
                .
            /* process event */
                .
            yield();
        }
}


task_2()
{
        for (;;) {
            while (count_2 > count_1) yield();
            wait(&event);
            ++count_2;
                .
            /* process event */
                .
            yield();
        }
}
```

The problem with the lack of prioritizing tasks with TJ/OS can be improved by using two event counters within a task as shown at left. Two tasks can then be made to consume a stream of events in strict alternation. Another approach to the mobbing problem is shown on the right. The stream of events is used in an equally fair but slightly more relaxed sequence.

THE C REALTIME EXECUTIVE

CX/PC from the INTR-Soft Company was created by Walter S. Heath, who set out to build a small realtime executive package for the Z80 processor; he published an article ("A System Executive for Real-Time Microcomputer Programs," *IEEE Micro*, June 1984) describing the difficulty he experienced in gathering design information. This led to his packaging the Z80 executive as a product, CX/80, and later to the creation of CX/PC.

The CX/PC package consists of an executive module, a set of reentrant data queuing routines, and example applications that exercise its multitasking and queuing facilities (table 2). It includes interrupt handling routines for serial and parallel ports and a simple timing mechanism. All modules are written using the DeSmet C compiler (some contain embedded assembly language code as well as C source).

As under TJ/OS, each CX/PC task runs with its own stack. In addition to its stack, a task's context includes a task control block (TCB) in which the task scheduler records status information that is used in scheduling and synchronization (see figure 5).

The CX/PC user cannot dynamically create or destroy tasks. The number of tasks in an application must be fixed at system generation time, and the storage space for each task's stack area and TCB must be allocated before or during system-wide initialization.

CX/PC's priority scheme is straightforward. As part of system initialization, all TCBs are chained together in a linked list, in an order determined by the system designer. A task's number is its ordinal position in this chain; task numbers are the means by which tasks identify each other when calling for service from CX/PC. The closer a task's TCB is to the beginning of the chain, the higher its effective priority.

Whenever a task relinquishes the processor, the CX/PC scheduler regains control and scans the chain of TCBs looking for a task that is ready to run. Scanning always begins with the first task in the TCB chain, and consequently this task always gets first crack at running. The nature of the chained data structure, in fact, dictates that no two tasks can have the same priority; one must appear earlier in the chain and thus will always receive more favorable treatment from the scheduler.

CX/PC, like TJ/OS, embodies a nonpreemptive task scheduling discipline. Once running, a task continues until it voluntarily calls the CX/PC subroutine **sleep**, at which time the scheduler saves

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its context and scans the list of TCBs for another task that is ready to run.

Where TJ/OS's scheduler blindly gives every active task a turn to run whenever it comes around in the rotation of active tasks, CX/PC's scheduler is more discriminating. It maintains in each task's TCB a flag indicating whether or not the task is ready to run. If a task is not ready, the scheduler passes on to the next one. A task that calls **sleep** indicates to the scheduler that it is no longer ready to run.

Sleep is similar to TJ/OS's **yield** primitive; it causes its calling task to surrender control of the processor. **Sleep**'s caller, however, does not automatically get a later turn to execute as **yield**'s caller does. Unless it makes arrangements to be restarted later, a task that calls **sleep** will remain dormant until another task reawakens it.

Sleep's counterpart is **wake**, which makes a task eligible to contend for processor time by marking its TCB. A task may awaken another task by calling **wake** and passing the dormant task's number. When this task is able to run, it resumes execution at a point in its code just after its last call to **sleep**.

Interrupt handling routines are permitted to **wake** tasks but are prohibited from sleeping. Because an interrupt handler can run at any time, regardless of the state of the multitasking environment, it can awaken the task that is already running. In this case, CX/PC notes in its TCB that the running task was awakened and, when the task later calls **sleep**, uses this information to override **sleep**'s normal operation by leaving the calling task marked ready to run.

The currently running task may be awakened in one other case: it may awaken itself. A task awakens itself not for immediate effect (it is already running and therefore awake), but to ensure that it will receive another chance to run after its next call to **sleep** even if no other task awakens it. The sequence of calls **wake(my_task_number)**, **sleep()** is similar in effect to a call to **yield** under TJ/OS; it relinquishes control of the processor, but with a guarantee that control will eventually return.

Sleep and **wake**, although they allow tasks some measure of control over each other, do not constitute a synchronization mechanism. A sleeping task is not waiting for anything in particular to happen. Similarly, a task that awakens a sleeping task has no idea of what the sleeper was waiting for.

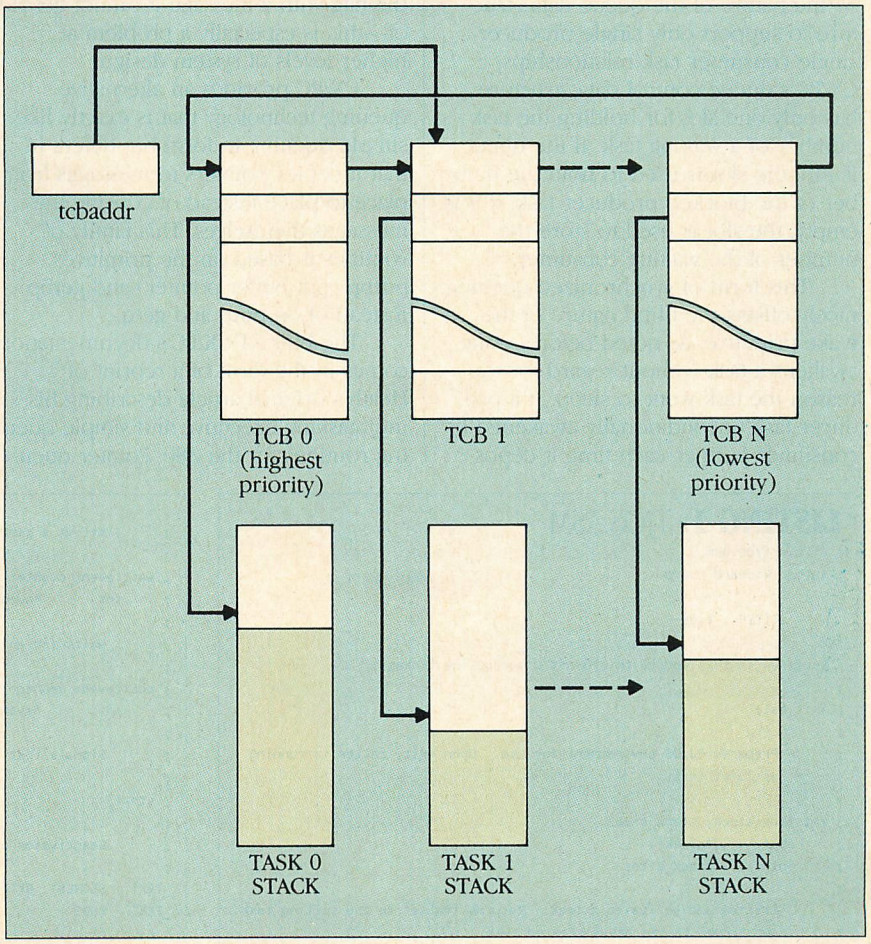
CX/PC's synchronization facilities are provided as a logical layer that sits atop the **sleep** and **wake** primitives, as

TABLE 2: *CX/PC Facilities*

MODULE	CONTENTS
cx1.c	Main program, system initialization, scheduler sleep( ) wake( )
quea.c	Simple message queuing putq( ) getq( )
quea2.c	Synchronized message queuing putqwt( ) getqwt( )
quea3.c	"Half-synchronized" message queuing and queue utilities putqwk( ) getqwk( )
	getqc( ) getqd( )
bptr.c	Pointer-based message queuing and associated utilities putbp( ) getbp( )
	putbpwt( ) getbpwt( ) getbpr( )
	putbpr( )

CX/PC can supply two different queuing technologies. Pointer-based message queuing is offered in the bptr.c module. Here, pointers to messages are copied instead of moving the messages themselves as in other simple queuing modules.

FIGURE 5: *CX/PC Environment*



The task scheduler records the information used in scheduling and synchronization in the task control block (TCB). Each task has an associated stack and TCB.

part of a data queuing apparatus. Two types of FIFO data queues are supported: one in which variable length messages are physically moved into and out of queues, and a second that manipulates pointers to messages.

The first type of queue management has as its foundation the routines **putq** and **getq**. **Putq** copies messages into a ring-structured buffer or reports failure if the buffer is full; **getq** copies messages out of a queue or reports failure if the queue is empty.

Fully synchronized queuing is provided by the functions **putqwt** (put in queue or wait if full) and **getqwt** (get from queue or wait if empty), which use **putq**, **getq**, **sleep**, and **wake**. These routines accomplish the synchronization required by two tasks in a producer/consumer relationship: **putqwt** waits for queue space if the queue is full, then puts a message in the queue and awakens the consumer task if it is waiting for a message; **getqwt** waits for a message to be deposited if the queue is empty, then removes a message and awakens the producer task if it is waiting for space in the queue.

Putqwt and **getqwt** are constrained by the nature of the queue data structure to support only single producer, single consumer task relationships. CX/PC's queue control data structure has only one slot for holding the task number of a waiting task. If the queue is full, the slot is used to hold the number of the blocked producer task; if it is empty, the slot is used to store the number of the waiting consumer.

This form of synchronized queuing nicely offsets the blind nature of the **wake** primitive. As noted before, **wake** awakens a task without regard for the reason the task went to sleep. If a producer task unconditionally awakened its consumer partner each time it deposited a message in their shared queue, it would risk rousing the consumer from its sleep waiting for some *other* event to happen, causing confusion at best and system failure at worst. This problem is avoided because a producer calling **putqwt** wakes its consumer only if the consumer's task number appears in the waiting task slot of the queue control data structure. The reverse is true for consumers calling **getqwt**.

CX/PC also provides half-synchronized simple queue management. The functions **putqwk** and **getqwk** are half-synchronizers; they awaken a task that is waiting for the condition they create (queue not empty or queue not full), but they will not themselves wait (by sleeping) for a condition to arise. **Putqwk**'s asymmetric operation is especially useful in constructing interrupt handlers that must queue messages to waiting tasks. If a queue is not full, **putqwk** deposits a message and awakens the waiting task. If the queue is full, it reports failure back to the interrupt handler. Because interrupt handlers may **wake** but not **sleep**, they must use **putqwk** instead of **putqwt**. A full queue may leave the interrupt handler holding the bag with a message it cannot get rid of—this is especially a problem at higher levels of system design.

CX/PC provides an alternative queuing technology that is exactly like simple queuing in form but differs in that it copies pointers to messages from place to place instead of copying the messages themselves. This family of routines is based on the primitives **putbp** (put buffer pointer) and **getbp** instead of on **putq** and **getq**.

The bulk of CX/PC's documentation comes in the form of a reprint of Heath's original article describing his multitasking executive and simple queuing routines for the Z80. Pointer queuing is documented only sketchily, but its use is illustrated clearly in the five example programs. CX/PC is delivered with complete C (and assembly) source code, so users conversant with C can resolve questions for themselves. Heath provides free technical support by telephone. CX/PC's licensing arrangement permits unlimited use and resale of the software in executable form at no additional cost, but prohibits licensees from reselling or otherwise distributing its copyrighted source code.

CX/PC furnishes priority-based, nonpreemptive multitasking and imposes minimal execution time overhead. Its synchronization facilities operate in conjunction with a variety of data queuing mechanisms. They support only single producer, single consumer task relationships, although nothing in the nature of CX/PC prevents the construction of richer, more flexible synchronizers; the **sleep** and **wake** primitives provide a simple but sound foundation.

CX/PC is suitable for small, PC-based instrumentation and control systems that can live without preemptive task scheduling. At $75 for source and an unrestricted binary license, CX/PC is an attractive option for those seeking a model and source of multitasking experience and ideas.

CX/PC: $75
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P.O. Box 351
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CIRCLE 350 ON READER SERVICE CARD

Richard M. Foard is vice president of software development for ROADNET Systems Corporation. *He would like to acknowledge Bill Appelbaum of the General Instrument Corporation for his help in developing TJ/OS, which was inspired by the written contents of Bill's napkin at lunch one day.*

LISTING 1: TJOS.ASM

```
; File:  tjos.asm
; Auth:  Richard Foard

        TITLE   tjos
;
; Routines in this module (Microsoft C subroutine linkage):
;
; init_os()
;
;       Prepares TJ/OS environment for use.  Upon exit, caller is running
;       as first task.
;
; int fork(stack, stack_size)
;     char      *stack;
;     int       stack_size;
;
;       Creates and activates a task.  Returns 'false' to the calling task
;       and 'true' to the newly created task.
;
; yield()
;
;       Allows a context switch to occur.
;
; wait(event_counter)
;     int       *event_counter;
;
;       Waits for an event.
;
; post(event_counter)
;     int       *event_counter;
;
;       Signals that an event has occurred.
;
; stop()
;
;       Deactivates and destroys the calling task.
;
_TEXT   SEGMENT  BYTE PUBLIC 'CODE'
_TEXT   ENDS

CONST   SEGMENT  WORD PUBLIC 'CONST'
CONST   ENDS
```

```
_BSS    SEGMENT  WORD PUBLIC 'BSS'
_BSS    ENDS

_DATA   SEGMENT  WORD PUBLIC 'DATA'
_DATA   ENDS

DGROUP  GROUP   CONST,  _BSS,   _DATA
        ASSUME  CS: _TEXT, DS: DGROUP, SS: DGROUP, ES: DGROUP

PUBLIC          _init_os
PUBLIC          _yield
PUBLIC          _fork
PUBLIC          _wait
PUBLIC          _post
PUBLIC          _stop
PUBLIC          __chkstk

_TEXT           SEGMENT
EXTRN           _exit:NEAR
_TEXT           ENDS

_BSS            SEGMENT
max_tasks       equ     8
ct_limit        equ     max_tasks * 2
task_tbl        dw      max_tasks dup (0)
cur_task        dw      0
actv_tasks      dw      0
                EVEN
_BSS            ENDS

_TEXT           SEGMENT

_init_os        PROC NEAR               ;init_os() {
        mov     cur_task,0              ; cur_task = 0;
        mov     actv_tasks,1            ; actv_tasks = 1;
        sub     ax,ax                   ; task_tbl[0..max_tasks - 1] = 0;
        mov     cx,max_tasks            ;
        mov     bx,offset task_tbl      ;
ini_1:                                  ;
        mov     [bx],ax                 ;
        add     bx,2                    ;
        dec     cx                      ;
        jnz     ini_1                   ;
        ret                             ;
_init_os        ENDP                    ;}

_yield          PROC NEAR               ;yield()
        push    bp                      ; (preserve BP)
        mov     bx,offset task_tbl      ; task_tbl[cur_task] = SP;
        mov     ax,cur_task             ;
        add     bx,ax                   ;
        mov     [bx],sp                 ;
yie_0:                                  ;
        add     ax,2                    ; do {
        cmp     ax,ct_limit             ;   cur_task = (cur_task + 2)
        jne     yie_1                   ;                   % ct_limit;
        sub     ax,ax                   ;
yie_1:                                  ;
        mov     bx,offset task_tbl      ; } while (task_tbl[cur_task]==0);
        add     bx,ax                   ;
        push    ax                      ;
        mov     ax,[bx]                 ;
        or      ax,ax                   ;
        pop     ax                      ;
        jnz     yie_2                   ;
        jmp     yie_0                   ;
yie_2:                                  ;
        mov     bx,offset task_tbl      ; SP = task_tbl[cur_task];
        mov     cur_task,ax             ;
        add     bx,ax                   ;
        mov     sp,[bx]                 ;
        pop     bp                      ; (restore BP)
        mov     ax,1                    ; return(1);
        ret                             ;}
_yield          ENDP

_fork           PROC NEAR               ;int fork(stack, stack_size) {
        mov     ax,actv_tasks           ; if (actv_tasks == max_tasks)
        cmp     ax,max_tasks            ;   exit(1);
        jne     for_0                   ;
        mov     ax,1                    ;
        push    ax                      ;
        call    _exit                   ;
for_0:                                  ;
        inc     ax                      ; actv_tasks = actv_tasks + 1;
        mov     actv_tasks,ax           ;
        pop     dx                      ; (caller's return addr)
        pop     ax                      ; (new task stack base)
        pop     bx                      ; (new task stack size)
        push    bx                      ; (restore caller's stack)
        push    ax                      ;
        push    dx                      ;
        push    bp                      ; (preserve caller's BP)
        mov     bp,sp                   ; (and caller's SP)
        add     ax,bx                   ; (establish new task's base sp)
        sub     ax,4                    ; (allow pop of fork's parameters)
        mov     sp,ax                   ;
        push    dx                      ; (new task return addr)
        push    ax                      ; (and bp register image)
        mov     bx,offset task_tbl      ; (find free slot in task_tbl)
for_1:  mov     ax,[bx]                 ;
        or      ax,ax                   ;
        jz      for_2                   ;
        add     bx,2                    ;
        jmp     for_1                   ;
for_2:  mov     [bx],sp                 ; (install new task in task_tbl)
        mov     sp,bp                   ; (restore caller's stack)
        pop     bp                      ; (and BP)
        sub     ax,ax                   ; return (0);
        ret                             ;}
_fork           ENDP

_wait           PROC NEAR               ;wait(event_counter) {
wai_0:  pop     cx                      ;
        pop     bx                      ;
        push    bx                      ;
        push    cx                      ;
        cli                             ; (protect test-and-set)
        mov     ax,[bx]                 ;
        or      ax,ax                   ;
        jnz     wai_1                   ; while (*event_counter == 0)
        sti                             ;
        call    _yield                  ;   yield();
        jmp     wai_0                   ;
wai_1:  dec     ax                      ; --(*event_counter);
        mov     [bx],ax                 ;
        sti                             ;
        ret                             ;}
_wait           ENDP                    ;

_post           PROC NEAR               ;post(event_counter) {
        pop     cx                      ;
        pop     bx                      ;
        push    bx                      ;
        inc     word ptr [bx]           ; ++(*event_counter);
        jmp     cx                      ;
_post           ENDP                    ;}

_stop           PROC NEAR               ;stop() {
        mov     ax,actv_tasks           ; if (--actv_tasks == 0) exit(0);
        dec     ax                      ;
        jnz     sto_0                   ;
        sub     ax,ax                   ;
        push    ax                      ;
        call    _exit                   ;
sto_0:                                  ;
        mov     actv_tasks,ax           ;
        mov     bx,offset task_tbl      ;
        mov     ax,cur_task             ;
        add     bx,ax                   ; task_tbl[cur_task] = 0;
        mov     word ptr [bx],0         ; (join 'yield' to switch context)
        jmp     yie_0                   ;}
_stop           ENDP

__chkstk:                               ;chkstk:
        pop     cx                      ; (allocate AX bytes of stack space)
        mov     bx,sp                   ;
        sub     bx,ax                   ;
        mov     sp,bx                   ;
        jmp     cx                      ;

_TEXT   ENDS
END
```

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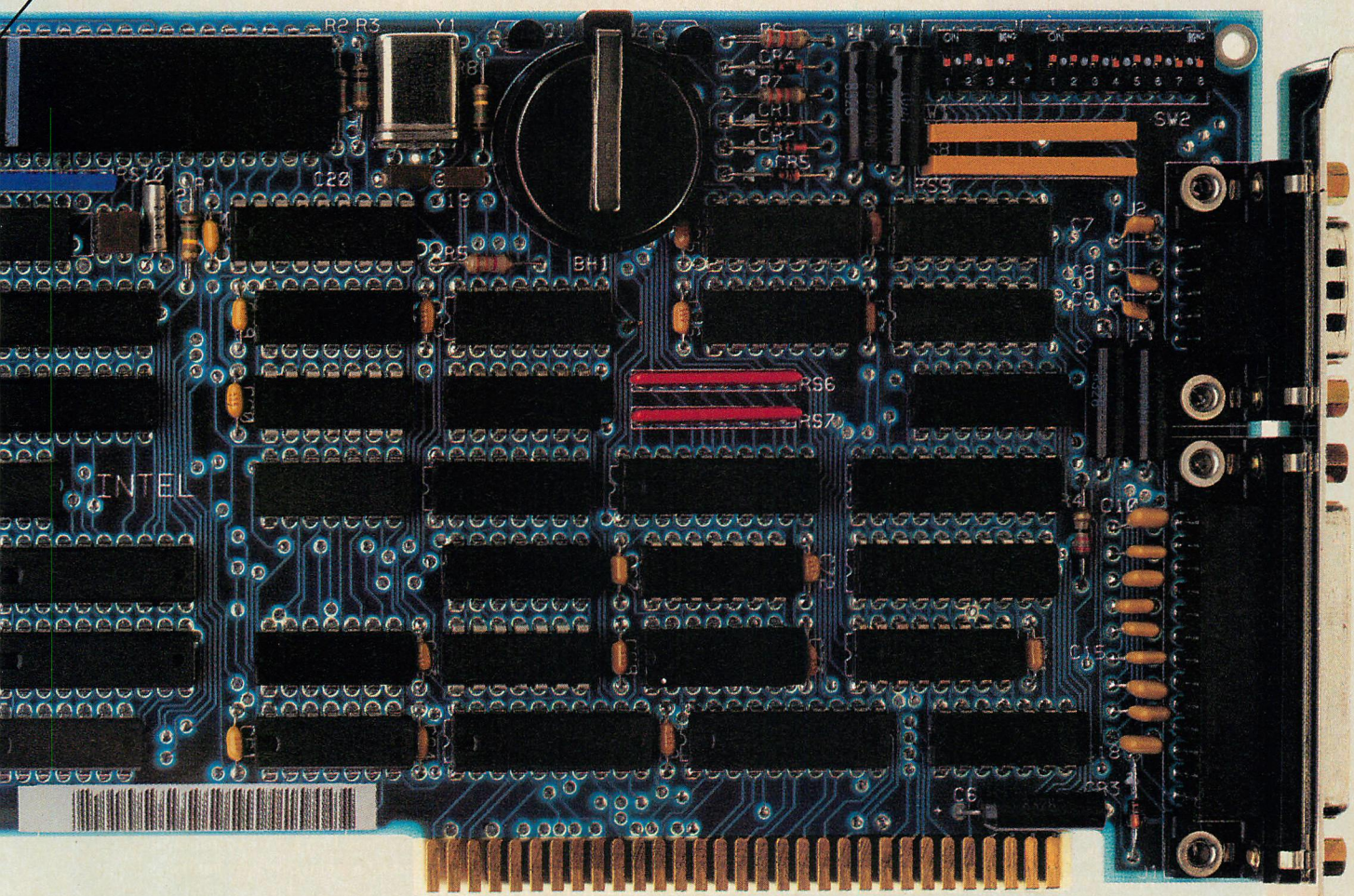
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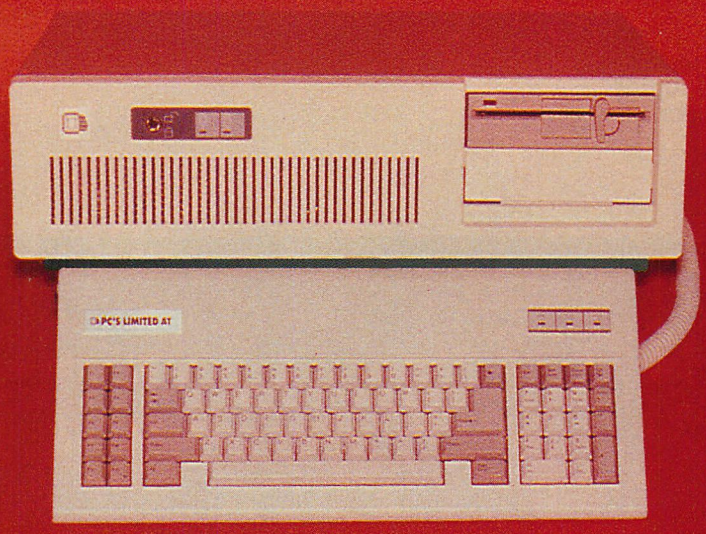
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CIRCLE NO. 145 ON READER SERVICE CARD

Breaking out with Periscope

This symbolic debugger, with its breakout button and powerful command options, stands unrivaled for its flexibility.

WARD CHRISTENSEN

ILLUSTRATION • ANDY LEVINE

Periscope is a symbolic debugger that can be accessed from anywhere within an operating system or a specific application with one simple press of a button. It provides a superset of DEBUG's commands and is equipped with the hardware necessary to protect against the dangers of most system crashes. The convenient breakout button invokes the debugger with a nonmaskable interrupt (NMI), and an optional protected memory board shields it from applications that can wipe out memory. Periscope can accept the symbol information of some popular C, Pascal, FORTRAN, BASIC, and as-



sembly language compilers. In addition, because it relies only minimally on custom hardware, Periscope can be used on an IBM PC, PC/XT, or PC/AT, as well as many clones.

Periscope is a hardware-assisted debugger; it falls between software debuggers, such as DOS's DEBUG, and hardware-assisted debuggers that monitor the processor and bus. (See "Untangling Programs," Steven Armbrust and Ted Forgeron, April 1985, p. 81 for a review of hardware-assisted debuggers.) Periscope lacks the power of debuggers that monitor the CPU directly; it cannot, for example, trace a program running at full speed. However, it duplicates functions of hardware debuggers that cost ten times as much.

Periscope is available in two models: I and II. Both include the debugging software and a breakout button equipped with a five-foot cable. Periscope I includes a memory board with 16KB of protected memory. The software can be configured to reside entirely on this board, thus taking up none of the PC's 640KB of contiguous memory. This configuration protects against runaway programs (because only the NMI vector is exposed) and allows for non-DOS debugging. A user working in another operating system need only point the NMI vector (INT 2) to Periscope to access the debugger.

Users who have no need of the added features of Periscope I should opt for Periscope II, which does not include the protected memory board. It is memory resident and costs about half as much as Periscope I.

THE BREAKOUT BUTTON

Periscope's breakout button allows the user to take control of the debugger under any circumstances. With this unique feature, the user can, for example, interrupt a program caught in an infinite loop. Spontaneous use of the button can reveal where a slow-running program spends its time.

The breakout button can come in handy in other situations, also. For example, Periscope was used on a disk formatting program that had the annoying habit of spinning the disks with the head engaged until it received the go-ahead character and started formatting. When it finished formatting one disk, it looped back to its prompt and spun the heads again. By hitting the breakout switch at that point and examining the program flow, an appropriate patch could be fashioned.

Another case of unplanned debugging involved reverse video on a color screen. The screen was blanking (to black) whenever scrolling occurred. By putting Periscope into trace mode it was able to look for the code that blanks the screen. Periscope found the code residing in ANSI.SYS. It then erased the blanking and the wait-for-retrace code, which resulted in a much more pleasant display.

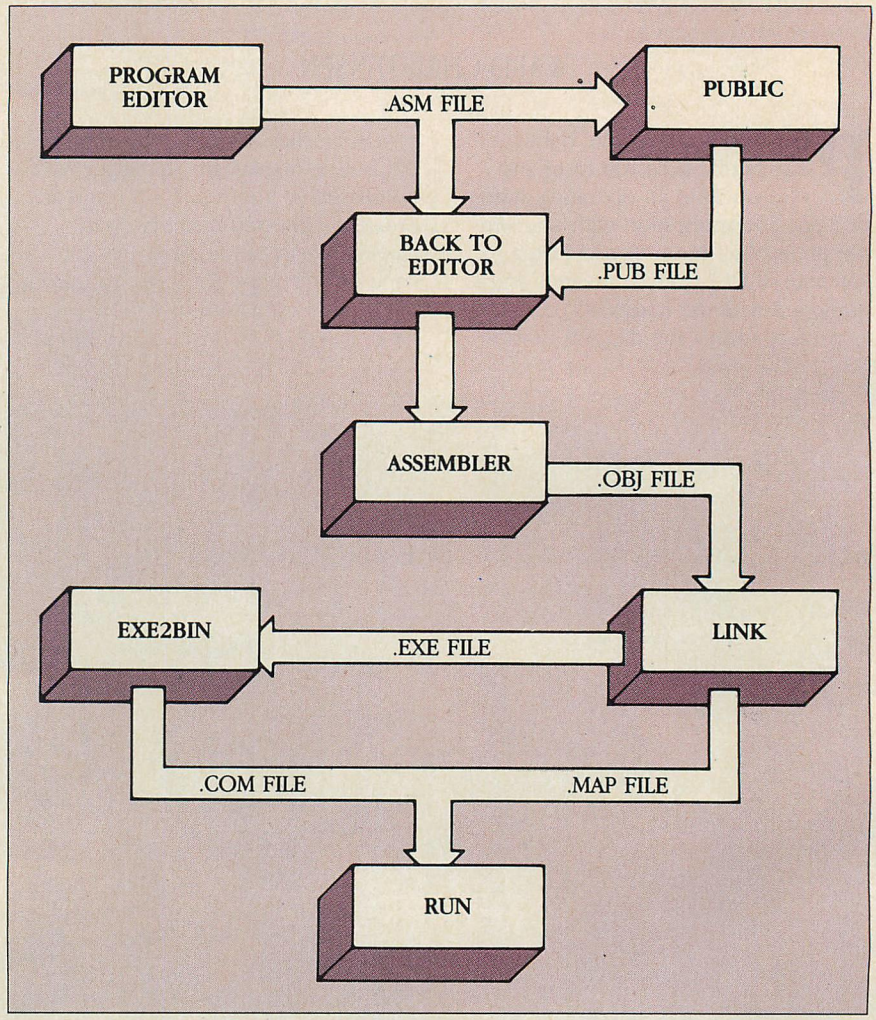
Periscope again saved the day when the message buffer of a communications program was accidentally

FIGURE 1: *Interleaved Source*

```
>us .a36                              <-- Unassemble source line 36
Source file for module A ? ascii.c    <-- Periscope asks for filename
A36:            if(argc<2)            <-- interleaved source code
1AC6:0249 837E0A02      CMP     WORD PTR [BP+0A],+02
1AC6:024D 7D2C          JGE     A43
A37:            {       puts("Syntax:");
1AC6:024F B8DE08        MOV     AX,08DE
1AC6:0252 50            PUSH    AX
1AC6:0253 E82613        CALL    PUTS
1AC6:0256 8BE5          MOV     SP,BP
A38:                    puts("\tascii filename");
                                      >
```

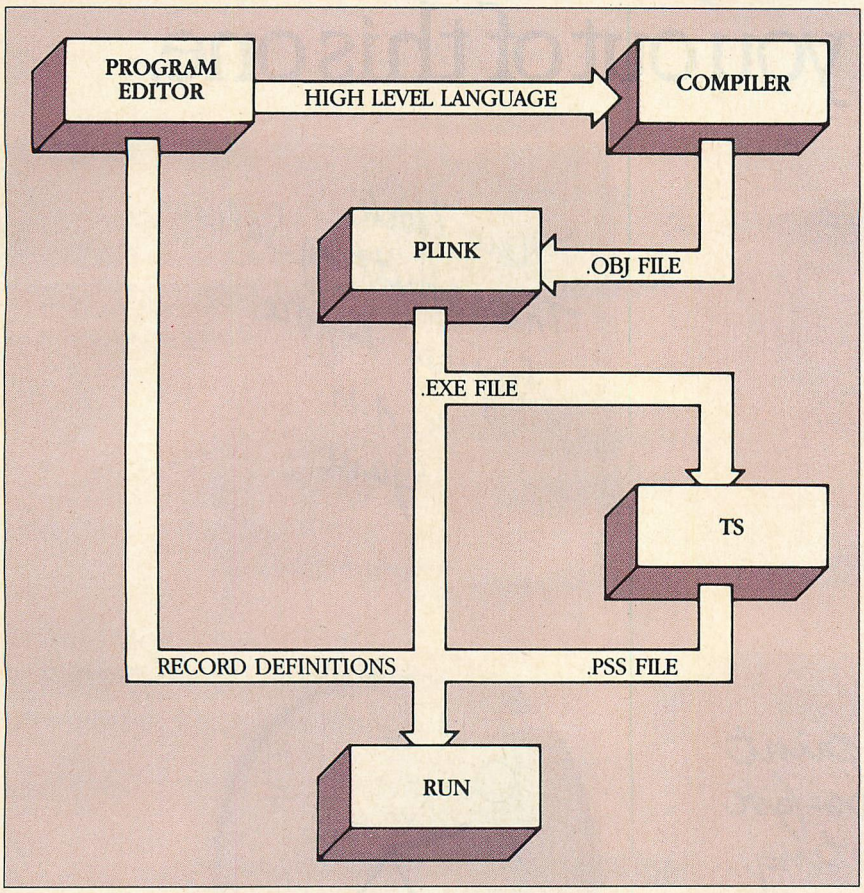
A symbolic debugger is able to interleave source code with the machine instructions that a compiler produces from that source code. The compiler must supply the symbol and line number information required by the debugger.

FIGURE 2: *Assembly Language Symbols*



Symbol information is transferred from a programming set-up to Periscope's RUN.COM debugger, and assembly language source is compiled to a .COM file. Periscope's PUBLIC.COM ensures that all source code symbols are declared public.

FIGURE 3: *High-level Language Symbols*



A different choice of language and linker necessitates a different path for symbol information. Above, a high-level language is compiled to an .EXE file. Variables are declared public, and the optional record definitions are placed in a regular text file. Note that Periscope works with Phoenix's Plink as easily as with DOS's LINK.

deleted. I hit the breakout switch, found the data, moved them up high in memory, and returned to the communications program. I later moved the data down and wrote them to a file.

Using Periscope to trace the INT 16 keyboard interrupt revealed that the Seaware Extended Batch Language (BAT) did not simply place characters in the DOS keyboard buffer, thus limiting the number of characters that could be stacked and possibly causing problems when the user tried to run another program. Instead, it was taking control of the system to check the queue for entries. Only then did it pass control on to the BIOS. DOS's DEBUG would have been inadequate in this situation; it has trouble tracing programs that are not loaded by DEBUG.

Periscope is a real help in debugging C programs because line numbers and symbols are available. The user can learn much about a compiler by interleaving lines of C source code with the assembly language code that those source lines generate. The assembly language code generated by Lattice C is shown in figure 1.

Using Periscope to perform traces in DOS also can be instructive, but the user should be aware that an NMI can scramble the stack registers in older copies of DOS 2.x (see "Patching a Bug in DOS 2.1," Tech Notebook 27, Don Awalt, November 1984, p. 71). The errors, which also affect single-stepping through DOS, are caused by the order in which SS and SP are loaded.

Periscope I's design allows debugging of non-DOS operating systems and device drivers (which load before the user gets a DOS prompt). To use the debugger in systems other than DOS, the user must load DOS and install Periscope as usual, then select Periscope's short boot option to jump into the non-DOS system. Periscope will continue to function because it uses DOS calls only to read and write disks. Periscope's memory is protected; thus, no other system can modify it. If the system overlays the NMI interrupt vector pointing to Periscope, the user can write a program under a second operating system that will point the NMI back to Periscope. Periscope II also can be used to debug non-DOS systems if it is successfully hidden from the new operating system. Neither version of Periscope works with 80286 operating systems that switch to protected mode.

Periscope is hardware protected; however, it cannot survive all system crashes. Two particular points of vulnerability exist. First, as mentioned above, a program can overwrite the NMI vector. In addition, a program could mask the ports through which NMI travels.

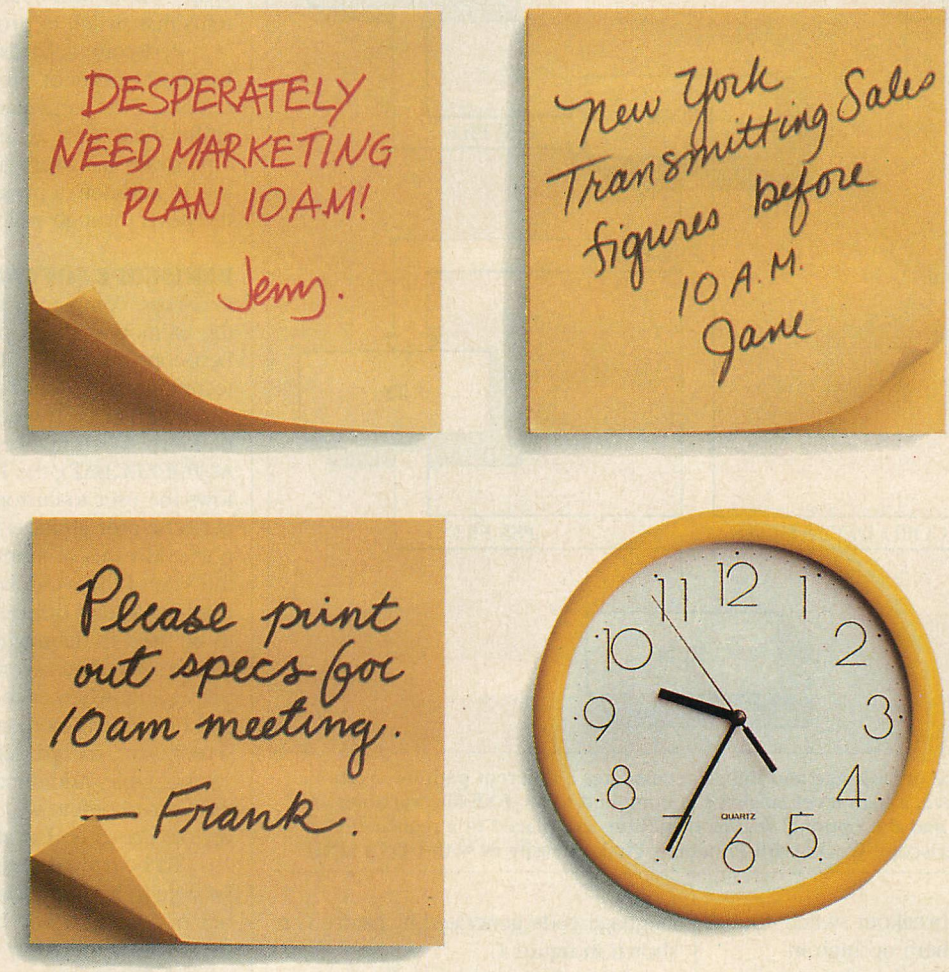
PERISCOPE SOFTWARE

Periscope commands are processed by the memory-resident program PS.COM. Periscope I loads PS.COM into the protected memory board (called Submarine); Periscope II loads it into DOS memory. When invoked (usually from AUTOEXEC.BAT), the PS command allows the user to customize the debugger. The user chooses the memory and port addresses of the Submarine board; the size of the windows for dump, register, stack, and disassembly; the color to be used in debugging displays; whether to use a second monitor for debugging; whether to install help text; and how much memory to reserve for screen save, record definitions, and the symbol table. Additional options allow the user to define which BIOS interrupt vectors are to be left alone.

To be truly useful, Periscope must be able to accommodate a large number of compilers and linkers, a requirement it fills admirably (see figures 2 and 3). The user can access public variables from Lattice, Microsoft, IBM, and Computer Innovations C, as well as from Microsoft and IBM Pascal. Any assembler that allows public symbols (in other words, almost any assembler) can pass symbols to Periscope. Some symbol information is available from Microsoft and IBM BASIC. Periscope accepts MAP files directly from DOS's LINK, and special utility programs allow Periscope to use symbol information from Phoenix and DRI linkers.

Several ancillary .COM files implement symbol support and record definitions. The user must provide these Periscope programs with the appropriate synmbol and line number information (see figures 2 and 3). This involves declaring variables public and specifying a compiler option as well as the necessary linker options. In Lattice C, for example, the user invokes the -d compiler option to include line numbers in the .OBJ file. The /L and /M options of

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DOS's LINK will pass this information along to the .MAP file.

Periscope's utilities aid in this process. The PUBLIC.COM utility in figure 2 reads .ASM files and produces lines of assembly language that declare all symbols public. The lines are merged back into the .ASM file with a text editor. The TS.COM utility shown in figure 3 accesses symbol and line number data from Phoenix and DRI linkers.

The capability to perform record definition is another advantage of Periscope (see figure 4); the user defines records with an ASCII editor. Definitions for the file control block, the program segment prefix, the .EXE file header, and the Periscope data header are included on the distribution disk.

The Periscope program RUN.COM loads a file along with its symbols and record definitions; it is analogous to DEBUG. Because all Periscope commands are available through the resident PS.COM program, RUN.COM is needed only for symbol and record support or for traces that must be started before a program is executed.

RUN is better suited than DEBUG for work on programs with bugs related to memory position. DEBUG loads programs higher in memory than they normally would run; DEBUG's code is resident below the running program. RUN passes control to the resident PS debugger, and the program is loaded where it normally would be loaded.

BETTER THAN DEBUG

Periscope's commands are more powerful than those of DEBUG (table 1 shows a selection of these commands). Many single-letter functions, such as D (dump), can take an optional suboperand: DB dumps in byte format (this is the only format DEBUG supports); DW dumps words; and DD dumps double words. The DR command dumps an area of storage based upon the appropriate record definition. For example, DD 0:0 gives an interrupt vector dump that groups segment and offset together. The resulting entries look like F000:FEA5..., which is a very readable format. A record definition can be created to lay out the common interrupt vectors. Thus, typing DR 0:0.INT with each interrupt vector named produces a nicely formatted dump.

Because of Periscope's many options, the user must specify a suboption or enter a space following the primary option. Typing D100 (as required with DEBUG) produces an error. Instead, the command must be typed with a space following the D or as DB100. If no suboption is specified, the dump format remains as it had been specified previously. For example, DD 0:0 dumps from 0:0 in double word format, and any subsequent D commands continue to dump in that same format.

FIGURE 4: *Record Definitions*

```
>v fcb.def                                        <-- view definition text
\FCB            ; File Control Block
Drive,b,1       ; Drive 0=default, 1=A, 2=B, etc.
File,b,8        ; File name
Extension,b,3   ; File extension
Block No,w,2    ; Current block number
Rec Size,w,2    ; Logical record size
File Size,d,4   ; File size
Date,w,2        ; Date of last update
Res.,b,10       ; Reserved for DOS
Rec No,b,1      ; Current relative record number
Rel Rec No,d,4  ; Relative record number from beginning of file
>
>dr ds:5c  .fcb                                  <-- dump FCB with definition
Drive       03
File        44 55 4D 50 20 20 20 20              DUMP
Extension   43 4F 4D                             COM
Block No    0000
Rec Size    0080
File Size   0000:0600
Date        0751
Res.        84 51 42 8E 00 00 00 8E 00 00 00 00 00 00 00 00     .QB..........
Rec No      00
Rel Rec No  6854:2D00
>
```

Record definitions are an ingenious new feature of Periscope. Here, a file control block (FCB) template makes sense of a memory dump. The FCB shown has been opened, and one record has been read.

Periscope is a symbolic debugger, which means that any time a numeric operand is allowed in a command, a symbol (preceded by an at sign or a period) may be used. Thus, when 1B7C equals buffer, the location can be dumped with DB1B7C, DB@buffer, or DB.buffer. The MAP file has symbol entries for PUBLIC labels only. As a result, the user may want to make many of the labels in a program PUBLIC so they can be referred to during debugging. Periscope supplies a program called PUBLIC.COM that makes all labels in the ASM program public.

The A command assembles input into memory. It allows symbols to be referenced. An AU command unassembles each line as it is assembled to ensure that Periscope assembled the lines as the user expected. For example, if the user types in the line

MOV AL,[BX]+2

Periscope immediately returns

8A4702 MOV AL,[BX+02]

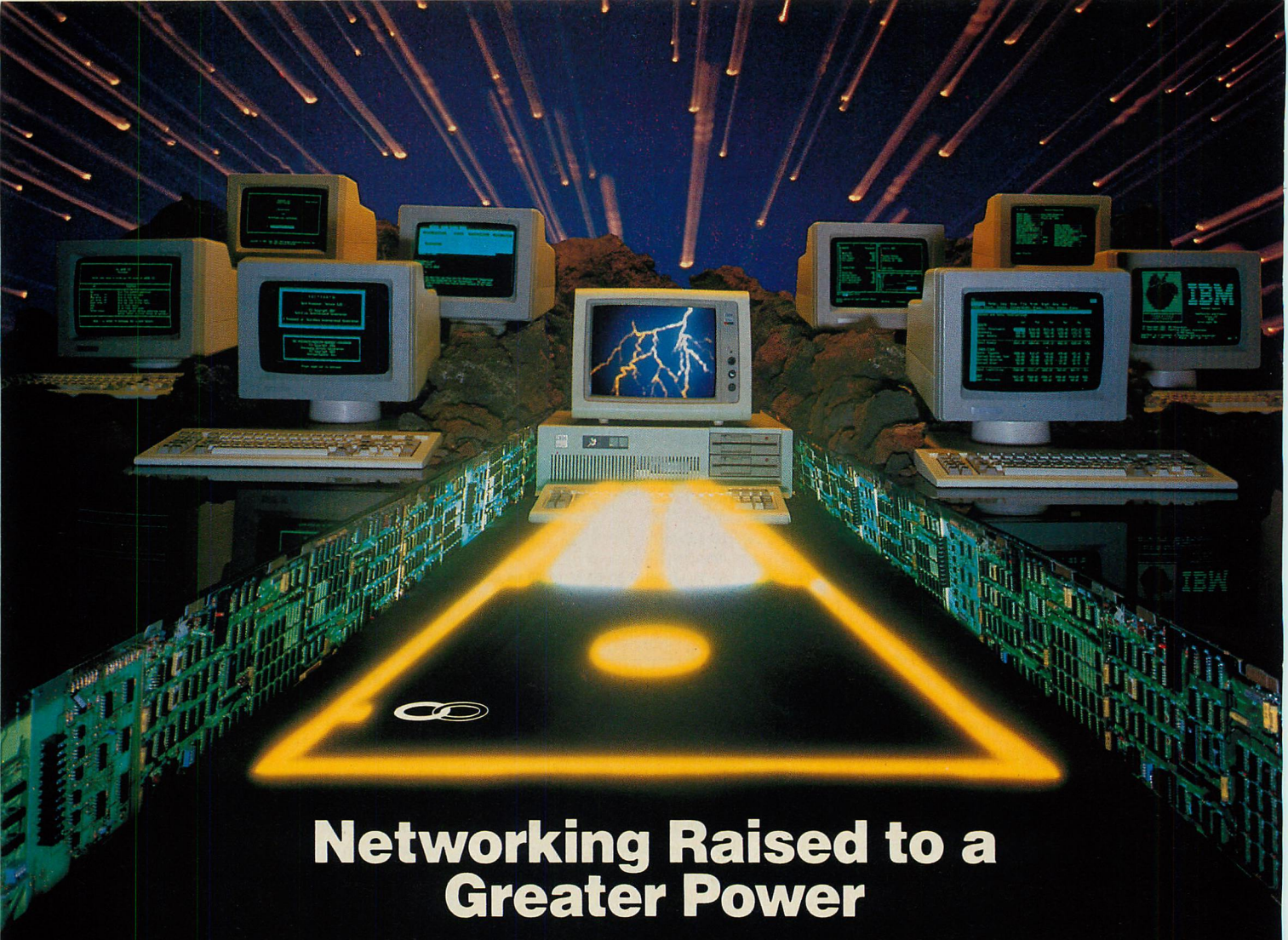
Periscope's response implies that it prefers the offset from base to be included within the brackets.

The G command (go) is similar to that command in DEBUG—it begins full-speed execution. One or more temporary breakpoint addresses may be specified. Execution returns to Periscope when any of the temporary breakpoints are executed or when the breakout switch is pressed.

The BC command (breakpoint code) is used for more sticky breakpoints than the temporary ones that are specified with the G command. The command BC<address> sets a code breakpoint that remains in effect until cleared with BC* or disabled with BC−.

Other variations on the breakpoint command are possible; all require execution in single step mode, which is invoked with the GT command (go in trace mode) and which uses the 8088 single step hardware interrupt. Periscope single steps from several hundred instructions per second (with some tests enabled) to more than 1,000 instructions per second (when GT is executed with no tests enabled). This rate allows the user to monitor the screen and press the breakout switch immediately following any particular condition.

The commands and conditions that can be tested while running under GT are: BB to breakpoint on a byte of memory meeting some condition (less than, greater than, equal to, or not equal to some value); BI to break when the next software interrupt is executed; BL to break when the next source line (of a high-level language) is executed, which allows the user to single step lines of a high-level program; BM to



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TABLE 1: *Selected Commands*

DUMP MEMORY	
DB	Dump in byte format
DW	Dump in word format
DD	Dump in double word format
DI	Dump in unsigned integer format
DR	Dump into user-defined record template
TRACE EXECUTION	
G	Start execution at full speed
GT	Execute at reduced speed, monitoring all breakpoints
BREAKPOINT OPTIONS	
BB	Set breakpoint on byte =, <,>,<> specified value
BW	Same as BB but compares words instead of bytes
BR	Break on register =,<,>,<> value
BI	Break on next interrupt call
BL	Break on next source code line
BM	Break when range of memory referenced
BP	Break when particular port referenced
BU	Break on a user-specified condition
BA	Display, enable, disable or clear all above breakpoints
BC	Set a permanent breakpoint (trace mode not required)
MISCELLANEOUS	
SU	Search memory for assembly language operand
ES	Define a new symbol and add it to table
DE	Display effective address of current instruction
US	Interleave lines of source with assembly language

Part of Periscope's versatile command set is listed above. Each command has further suboptions; those with numeric arguments accept symbols. If "BUFFER" is at 1B7CH, then DB.BUFFER is equivalent to DB 1B7C.

breakpoint on some memory range being read and/or written; BP to break when a particular port is read or written; BR to breakpoint on a register meeting some arithmetic condition; and BW to breakpoint on a memory word meeting some condition. A user-specifiable breakpoint, BU, allows the user to write an assembly language program to test for "anything he wants." It is called by Periscope and returns a flag that indicates whether or not a breakpoint should be taken. This could be used, for example, to instruct that a break be taken only when an INT 17 is executed with a 1BH (escape) in AL.

The final breakpoint commands enable, disable, clear, or display breakpoints. Each applies to an individual breakpoint, except BA which indicates all breakpoints. Examples include:

BA+ enables all breakpoints
BM− disables memory breakpoints
BB* clears all byte breakpoints
BA? displays all breakpoints

The M command is used to move a block of memory from one location to another. It checks for overlap before carrying out the relocation and automatically moves backward to prevent data loss. This can be useful when creating a program under RUN to move code up some number of bytes to make room for an additional instruction.

The S command searches for a hex or ASCII string in memory. The SA option searches for references to an address. SU searches for assembly language instructions; it invisibly disassembles each line, then compares the line with the specified operand. An example of its use is:

```
SU CS:100 L300 "IN AL,DX"
```

Note that the opcode column must be exactly eight bytes wide if an operand is specified. A search for IN returns any occurrences of INC as well as IN.

As in DEBUG, the E command in Periscope enters hex data into memory. ES enters symbols into the symbol table. This can be used to breakpoint a location that does not have its own symbol. By first entering

```
ES 17BC:237 .TEST
```

the user later enters

```
G .TEST
```

to go and set a temporary breakpoint at that instruction, or

```
BC .TEST
```

to set a permanent breakpoint.

The R command displays a register and, when followed by a register name (RCX), modifies that register. RF displays the current flags and pauses to allow the user to modify them. To change to the zero flag, for example, the user simply types RF;ZR.

The F command fills memory with a specific byte value. The operand may be a hex value, a character string, or a combination (for example, "test",D,A stores the ASCII string test, then a hex carriage return and line feed).

Hex arithmetic is performed with the H command. The I and O commands input and output values, respectively, to a port. The screen is cleared with K, which is most useful when combined with other commands. For example, K;D clears the screen and dumps memory, which is preferable to the simple scrolling that is accomplished with D. Disk I/O is supported via an L command to load and a W command to write. Both support either absolute disk sectors or named files. The N command places a file name in the default file control block and text buffer.

Two kinds of tracing are supported: T (similar to the T command of DEBUG) executes a single instruction; J jumps over CALLs and INTs while tracing by automatically setting a breakpoint at the instruction that follows the CALL or the INT. Thus, it can run at full speed. Periscope switches back to the application's screen during each T or J command so that screen updates are recorded. The user can bypass the screen updates by using TN or JN.

If Periscope is set for a register window (see the description of windows below), the T and J commands produce only one or two lines—the instruction line and an optional memory reference line—and do not display the registers along with the instruction. As a result, more traced instructions can fit on a screen. However, this also makes it more difficult to follow changes made to the registers because they are updated in a fixed location, not scrolled with the instructions.

The Q command is used to quit Periscope. It returns the user to the application screen and displays a two-line window that includes the following options: (B)oot, (C)ontinue, (D)ebug (or return to Periscope), (S)hort boot, and (R)eturn to DOS. Return to DOS is applicable only in programs that were loaded with the RUN command. The user also can specify these options in conjunction with Q: QB quits and reboots; QC quits Periscope but continues execution. Note that QC differs from



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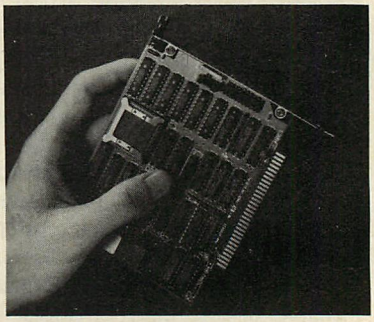
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the G command because G sets code breakpoints and QC does not.

Translation between decimal and hex is accomplished with the X command; X and XH take a hex operand; XD takes a decimal operand. The result of all three is a line showing the hex, decimal, binary, and ASCII equivalents of the operand. XA adds a segment and offset, producing a 20-bit absolute address. Neither symbols nor arithmetic can be used as part of any X command.

Like DEBUG, Periscope has a U command to unassemble. Because of the added convenience of symbols, Periscope's unassembled code is more readable than that produced by DEBUG. The US command interleaves lines of source code from a high-level language program with the disassembly. (See figure 1.) To retrieve the number of the lowest line in a program that generated code, the user types an *a* then presses F8. This displays all symbols that start with the letter A. In figure 1, line 36 and its symbol A36 were first in the program to meet this criteria.

Segments in the symbol table are relocated with the /S command. This is useful when symbol support is needed to debug a resident routine. The process is performed in three steps: the routine RUN.COM loads the symbol table (RUN.COM also loads a second copy of the routine into higher memory); /S changes the segment offset from the program loaded by RUN.COM to the resident copy of the same program; and QR, typed at the Periscope prompt, returns the user to DOS without executing the new copy of the routine. After these steps are executed, symbols that reference the resident routine are available for pushbutton debugging.

An optional user exit is possible with the /U nn command, which passes *nn* to the user routine in AH. A user exit must be loaded before Periscope and is invoked by using PS.COM and specifying the software interrupt used to access the routine. For example,

```
PS ...\U:60...
```

is used to specify that interrupt 60 (hex) is the user exit routine.

CUSTOMIZED SCREEN

With Periscope, the user can customize the screen, setting aside lines to display registers, stack contents, and other pertinent information. The /W command changes the Periscope windows; available operands include: R, which shows a register window; D:nn, which shows *nn* lines of data; S:nn, which shows *nn* lines of stack; and U:nn, which shows *nn* lines of unassembled commands. Remaining space on the screen is scrolled as commands are entered.

Periscope uses the function keys to good advantage. Keys F1 through F3 retain their DOS definitions and perform line editing. F4 copies the remainder of the previous command line and adds a carriage return. This is particularly useful, because it allows the user to reexecute a command. F6 toggles a pause on/off switch that halts Periscope when a single command (such as a long dump) fills the screen. F7 displays the current record definition names, and F8 displays the current symbols (if these records are more than one screen in length, the user can use F6 to pause from screen to screen while the records are being displayed). Keying in one or more letters of a command before pressing F8 restricts the symbol display to only those symbols that begin with the specified prefix. F10 switches between the Periscope screen and the application screen.

Command combinations can be built with semicolons used as separators. For example, K;U clears the screen and unassembles the next screen full of code. A second example, BR CS NE CS;GT, is more involved. This command remembers the current code segment (say F000) and begins running in monitored breakpoint mode until the code segment no longer matches the value of the code segment at the time the command was executed. In other words, this command runs until the code segment changes. It is useful for skipping segments that are of no interest and gives control to Periscope when the code segment returns to the program being debugged. If the new code segment still is not what the user desired, another press of F4 will reexecute the command until the code segment changes again.

Good technical support is another advantage of the Periscope software. The program's author answers all support calls himself.

Periscope provides some keyboard macro capacity for the function keys. An Alt-function key sequence assigns a command line to a key, and a Ctrl-function key replays the command. These function key definitions can be included in the record definitions file.

The debugger is easily installed. The user simply selects the appropriate memory address and ports for Periscope (the defaults are adequate for most users), plugs the memory and breakout board in a vacant slot (or inserts the breakout button lead for Periscope II, which requires no slot), and executes PS.COM. Some users may prefer to invoke the resident software from their AUTOEXEC.BAT files.

Submarine's 16KB of protectable memory may be installed at any 16KB memory boundary. It defaults to paragraph C000 hex, which is usually available. A conflict exists with the IBM Enhanced Graphics Adapter, which uses this memory address. Other boards, such as the Amdek Multiple Adapter Interface (MAI), also conflict. Running Periscope at paragraph B400 avoids the MAI conflict. Similarly, the port address that protects and unprotects the memory can be configured; it defaults to 300H and 301H, which is the address IBM reserved for prototyping boards.

Periscope II does not include the memory board. As a result, its installation involves only the breakout button. First, a ring terminal is placed under the retaining screw of an expansion board to connect it to ground. Then, a small bent wire is pushed betweed the gold finger on an expansion board and the board socket to connect it to bus pin A1. This allows the remote breakout switch to generate an NMI without taking up space on a board slot.

Good technical support is another advantage of Periscope. The author of the program answers all support calls himself. He was most helpful throughout the long period of review that preceded this article and was open to suggestions for improvements.

Periscope is a good product for the serious program developer. Less expensive symbolic debuggers and more powerful hardware debuggers are available, but Periscope's diverse features, affordable price, and portability place it in a class by itself.

Periscope I, $295; Periscope II, $145
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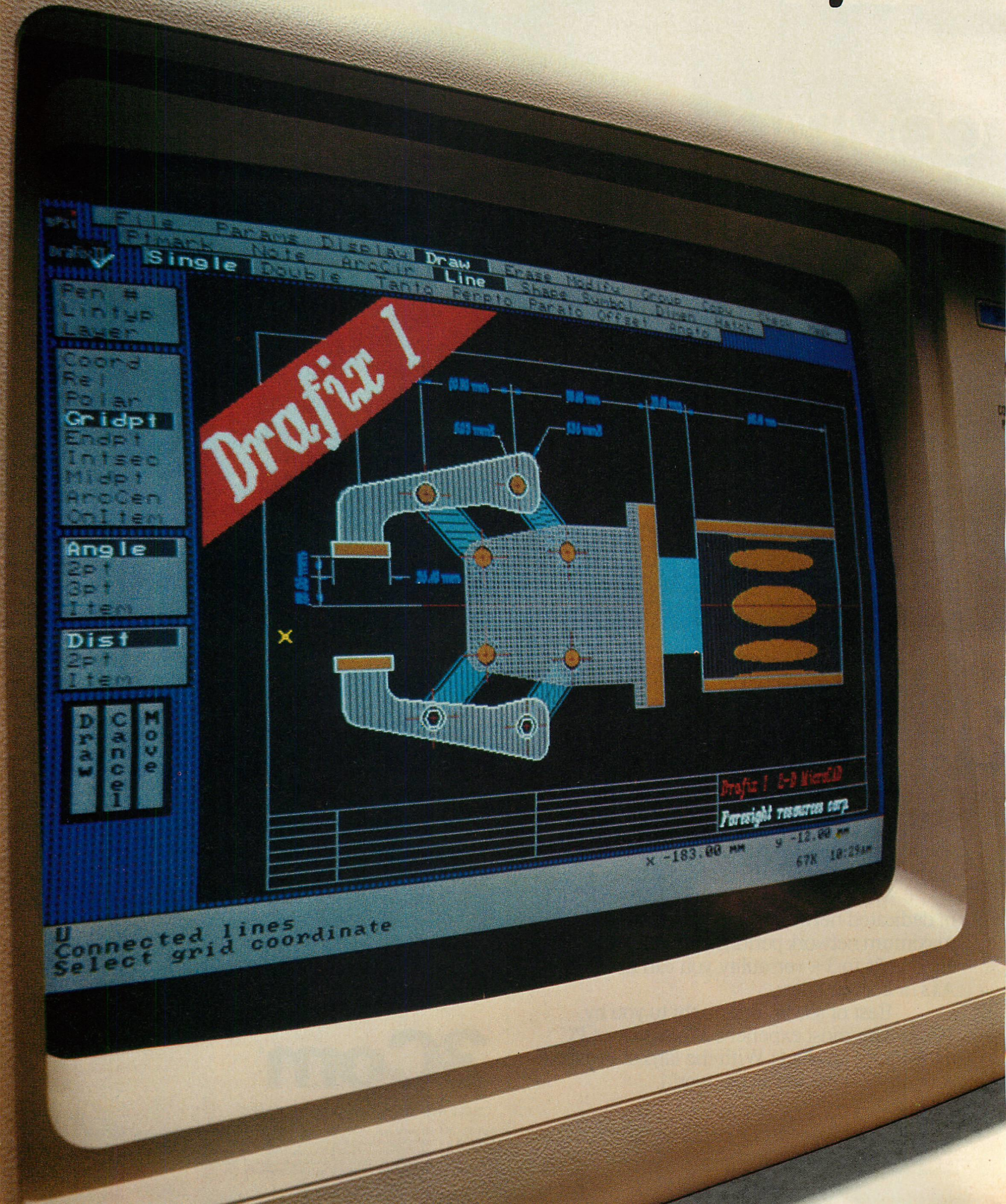
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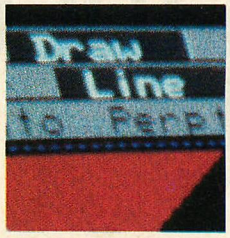
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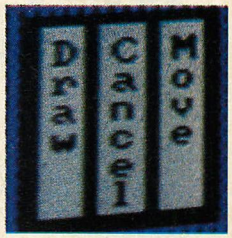
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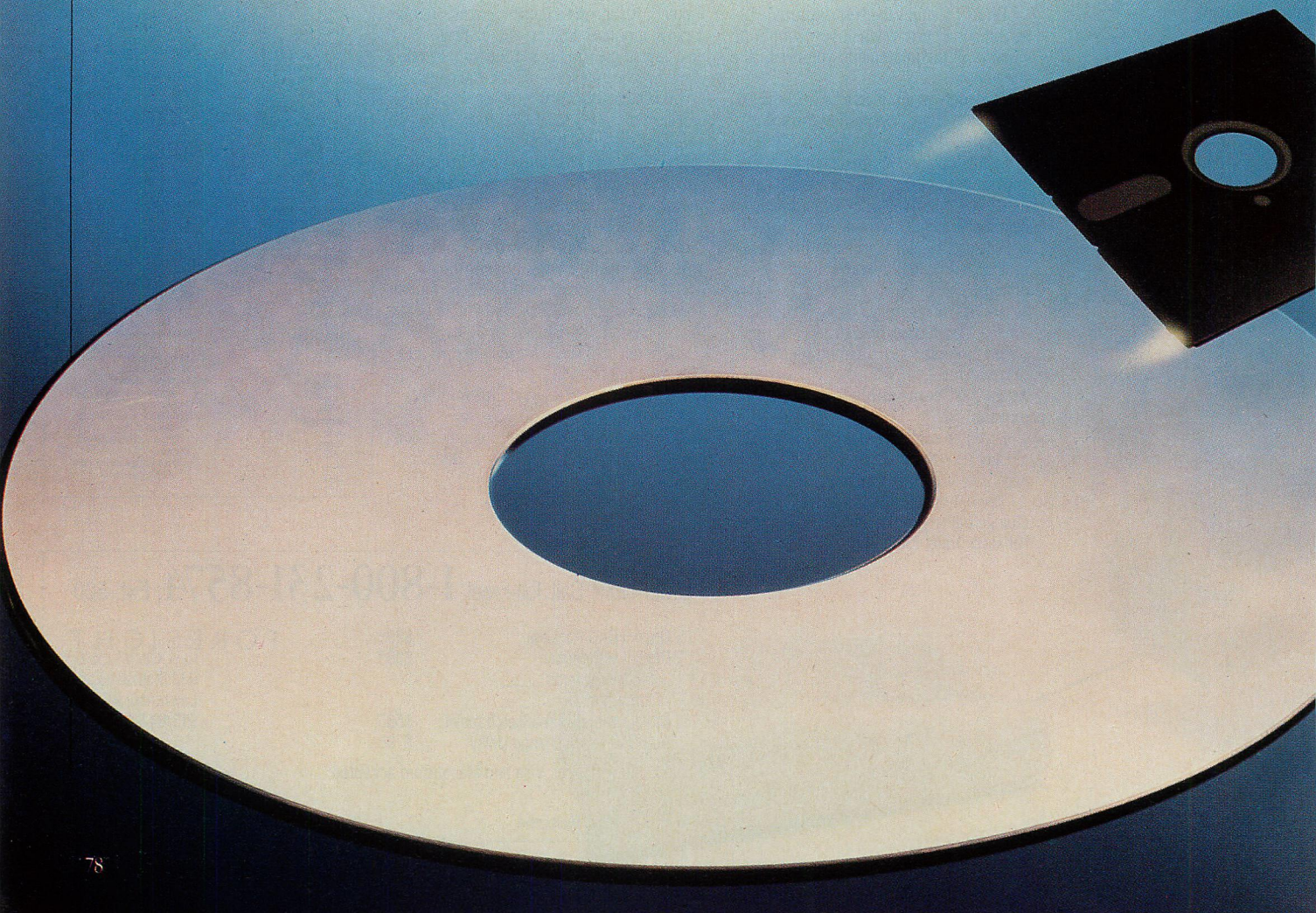
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Backup Utility Performance

STEVEN ARMBRUST and TED FORGERON

The task of backing up hard-disk files can be eased with an inexpensive software solution. Backup utilities are faster and offer more features than DOS BACKUP and RESTORE.





PHOTOGRAPH • MARC DAVID COHEN

"You can pay me now or you can pay me later" says a mechanic on a television commercial for automotive air filters. Buy a little preventative maintenance now, the mechanic advises, or you'll probably end up paying a bundle for repairs later. The message applies equally well to the hard-disk owner: he can spend a little time and money regularly backing up his hard disk, or he can spend a lot of time (and possibly money) attempting to recover from a fatal crash later.

Of course, tape backup units provide a fast and safe method of backing up a hard disk (see "Moving up to Tape," Steven Armbrust and Ted Forgeron, *PC Tech Journal*, November 1985, p. 62). But for the user who has just stretched his budget in order to buy a hard disk, or who has dug even deeper for an enhanced PC/AT, there may not be enough spare change left for an expensive tape drive.

Before resigning himself to using the standard DOS BACKUP and RESTORE commands, he should consider purchasing one of the special-purpose, hard-disk backup utilities now available. These utilities back up hard-disk files to diskettes, just like BACKUP and RESTORE, but they offer more features and faster operation. They still require swapping diskettes in and out of a drive, but considering the speed of some of these programs and the added capacity of the 1.2MB AT disk drives, the user may find that backing up data is not as odious as expected.

Five of the hard-disk backup utilities currently available are: BAKUP from Software Integration, Inc., DSBackup from Design Software, Dump/Restore from Cogitate, Inc., Fastback from Fifth Generation Systems, and BackTrack from Tallgrass Software Technology. (BackTrack, formerly known as Gemini Backup, was renamed when the developing company, Gemini Software, was purchased by Tallgrass Technologies Corporation.) An overview of their features is listed in table 1.

Among the five programs tested here, three distinct modes of operation were found. Fastback and Dump/Restore are command-oriented. Fastback is invoked by typing either FASTBACK (to back up) or FRESTORE (to restore). The user is then asked a series of questions about the files that are to be backed up or restored. Dump/Restore consists of several programs that can be used individually for special pur-

poses, such as displaying a tree structure of a disk's directories or setting file attributes, or combined in batch files to provide a full-featured backup utility.

Both BAKUP and DSBackup offer full-featured menu operation that greatly facilitates their use. Both also can be invoked from the command line. This permits setting up batch files to automate the backup process.

BackTrack offers the most unusual method of operation: although backup operations can be started from a menu, just like BAKUP or DSBackup, BackTrack is memory-resident. This allows it to perform backup operations in the background. Whenever the user stops typing for a few seconds (15 seconds at the DOS prompt or 60 seconds within another program), BackTrack activates and starts backing up any new or changed files automatically. When typing starts again, BackTrack stops and becomes dormant again.

Having a backup program work automatically in the background is a novel concept, but it does not work with BackTrack. Theoretically, backups are painless because they happen all the time, even while the user works on a Lotus 1-2-3 spreadsheet or dBASE III program. In reality the pain is merely shifted. While using BackTrack in automatic mode, one of the PC's floppy-disk drives must be dedicated to it. If the drive is needed for some reason, BackTrack's operation first must be suspended. If the user forgets and switches disks anyway, BackTrack will report that the wrong disk is in that drive.

A good reason for buying any backup program is the improved performance it offers over the standard DOS BACKUP and RESTORE. If it does not offer better performance, why bother? (Perhaps the user interested in the background operation of BackTrack would be willing to put up with lesser performance, because the backup happens in spare time anyway. But for the others, high performance is the key.) Table 2 lists performance benchmarks for the five programs. The DOS 3.1 BACKUP and RESTORE programs were included for comparison.

The tests were run on an enhanced AT with a 20MB IBM hard disk and an XT with a 10MB IBM hard disk. Both PCs included 640KB of RAM and were running DOS 3.1 with BUFFERS=20. The AT hard disk contained 1,859 files in 62 directories. The XT hard disk contained 834 files in 28 directories. The AT backups were performed using 1.2MB floppy disks; 360KB floppies were used with the XT.

TABLE 1: *Features Comparison*

	BACK-TRACK	BAKUP	DSBACKUP	DUMP/ RESTORE	FASTBACK
Version number tested	1.75	3.04.2	2.2[a]	1.04	5.02
Product copy-protected	Yes	Yes	No	No	Yes
Command-oriented operation	Yes	Yes	Yes	Yes	Yes
Full menu-oriented operation	Yes	Yes	Yes	No	No
Operates from batch file	Yes	Yes	Yes	Yes	Yes
Tracks incremental backups	No	Yes	No	No	Yes
Estimates number of diskettes	Yes	Yes	Yes	No	No
Estimates backup time	Yes	Yes	No	No	No
Verify switch included	No	Yes	Yes	Yes	Yes
Read verify included	No	No	No	Yes	Yes
Write verify included	No	Yes	Yes	No	Yes
On-line help provided	Yes	Yes	Yes	No	No
Generates printed reports	No	Yes	Yes	No	No
Uses DOS disk format	Yes	Yes	Yes	Yes	No
Compresses files on diskette	No	No	Yes	Yes	Yes
Formats diskette during operation	Yes	No	Yes	No	Yes
Re-use diskettes without reformatting/deleting files, directories	No	Yes	Yes	No	Yes

[a]*Design Software has released version 2.4 of DSBackup; it was not available in time for this review.*

All of these backup utilities provide similar functionality. One standout feature is the incremental backup catalog that is offered by both Fastback and BAKUP.

Full backups were done on both systems. For the AT, times also are shown for an incremental backup and restore of 500KB of files. Times for full restores are not given because in actual use, full restores are rare. Moreover, most of the time used in a restore operation is the overhead DOS adds in creating files and directories.

As table 2 shows, Fastback is the performance winner, executing full backups on the AT and XT in less than half the time of its nearest competitor. Its performance is poorer the first time it is run because it uses a nonstandard disk format and must format the diskettes before it can use them. However, once a set of Fastback diskettes is available, even some that contain old data, Fastback can proceed at the speeds that are indicated in the table.

Fastback's performance looks good even when compared to several of the tape backup units on the market. In "Moving up to Tape," backup times are listed for several popular .25-inch cartridge tape drives. Granted, a different (and slightly smaller) set of data was used for backing up to diskette, but Fastback's time of 10:55 seconds for a 10MB backup makes it considerably faster than tape drives such as the Adic Model 552 and Alloy PC-QICTAPE, and puts it about on a par with the Tallgrass 4060. Quite an achievement for a product that lists for approximately one-tenth the cost of a tape drive.

Of course, tape drives offer other advantages, such as unattended operation and error detection and recovery. But Fastback also offers the user a data detection and correction feature.

TABLE 2: *Performance Benchmarks*

	DOS BACKUP/ RESTORE	BACK-TRACK	BAKUP	DS BACKUP	DUMP/ RESTORE	FAST BACK
FULL 10MB PC/XT BACKUP (sec)	66:15	44:26	36:15	25:05	69:45	10:55
Number of 360KB diskettes	26	26	24	23	19	23
FULL 20MB PC/AT BACKUP (sec)	80:17	86:55	45:03	23:37	70:30	10:34
Number of 1.2MB diskettes	17	16	16	15	14	16
500KB AT BACKUP (sec)	01:10	00:50	00:34	01:30	01:56	00:24
500KB AT RESTORE (sec)	00:40	01:05	01:46	00:36	04:03	00:35

Clearly, Fastback was the fastest backup utility reviewed. Fastback uses two DMA (direct memory access) channels simultaneously to transfer data between the hard disk and the floppy, a method that is also employed by high-speed tape drives.

Fastback achieves its high performance using a technique that could cause problems with older PCs. It uses two DMA (direct memory access) channels simultaneously to transfer data between the hard disk and the floppy, a method also employed by high-speed tape drives. One DMA channel is used to transfer information from the hard disk into a memory buffer. At the same time, another DMA channel is used to empty the memory buffer and transfer the information to the floppy disk.

Although this simultaneous DMA process improves performance greatly, it will not work on a small percentage of older IBM PCs that contain defective 8237 DMA chips. The defective chips function correctly in normal operation, where only a single DMA channel is used at any one time. But when two or more DMA channels are used at once, timing problems prevent the proper transference of data.

Fifth Generation Systems acknowledges that this hardware problem does hinder some users of its product. But rather than slow down Fastback by using just a single DMA channel (even though it has a /SLOW option that does just that), the company offers a circuit board, sold separately for $40, that corrects the problem. The board plugs directly into the PC's 8088 socket, so as not to take up any expansion slots. Questions concerning difficulties should be addressed to the company.

All five programs tested offer a similar range of backup and restore options. The programs can back up and restore an entire disk, selected directories, or selected files. They also can do incremental backups; that is, backing up only those files that have changed since the last time a backup was done.

Incremental backups make lengthy backups tolerable. Instead of making a complete copy of the hard disk at every backup, a complete copy is made occasionally (once a month, for example). The rest of the time, incremental backups are done. For most users, this cuts the daily backup task down to a two- or three-minute job.

Unfortunately, with most backup systems (tape systems included), organizing and maintaining the set of backup data is left up to the user. He must keep track of which set of disks contains which daily backup because restoring the latest version of a file often involves starting with the last full backup and working in order through all the incremental backups. If disks or tapes are not labeled properly or otherwise become mixed up, it may be difficult (if not impossible) to reconstruct the file system.

If the backup utility uses DOS-formatted diskettes and the DOS file format, a file can be restored using the DOS COPY command.

Two of the utility programs, BAKUP and Fastback, offer a better way of organizing the incremental backup disks. Instead of forcing the user to keep track of each set of incremental disks, these utilities maintain their own catalog of files. The user simply labels the disks as indicated by the program. The program keeps track of which backup set a disk contains and where in the diskette set the latest version of each file resides. During a restore operation, both programs ask the user to insert the appropriate diskette.

DISK FORMATTING

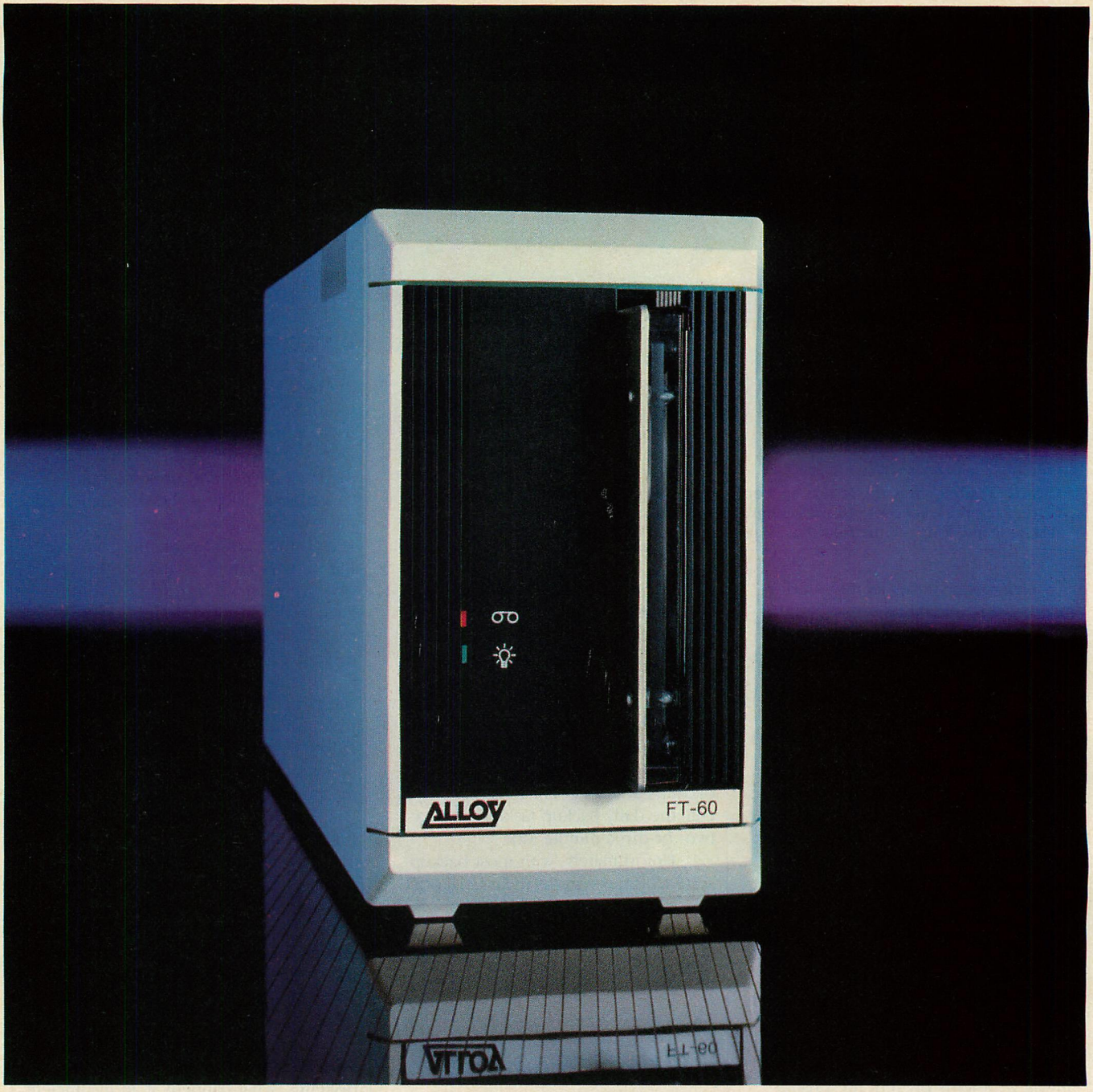
An important element of backup programs is the disk format. If DOS-formatted disks and the DOS file format are used, a file can be restored using the DOS COPY command, even if a bug in the backup program or some other catastrophe (such as the destruction of the sole copy-protected version) prevented the backup program from working. It may require searching through obscurely named directories on the backup disks, but it would be possible. BAKUP and BackTrack produce their backup disks using pure DOS files.

On the other hand, backup utilities can benefit by not using the pure DOS disk and file format. DSBackup and Dump/Restore, for example, use file compression techniques that minimize the number of diskettes needed.

Fastback takes the process one step further by using its own disk format. This nonstandard format not only compresses the data, but it also adds an error-correction capability. This allows Fastback to recover as many as 80 bad sectors on a 360KB diskette (one per track on each side of the disk). This recovery is possible even if the disk is damaged after the backup is made.

Given that these utilities require DOS-formatted (or specially-formatted) diskettes, what happens if an insufficient number of diskettes has been formatted before the backup program is run? Four of the products offer a solution to this problem. Fastback formats its diskettes on the fly—no need to format ahead of time. BackTrack and DSBackup can do the same for DOS-formatted diskettes by letting the user stop, format more diskettes, and continue where he left off. BAKUP cannot format its own disks, but before it starts backing up, it gives an estimate of the number of diskettes needed. If the user does not have that number on hand, he can abort the program at once. Dump/Restore provides no estimates, nor does it permit the user to stop and format more diskettes.

Three of the utilities, BAKUP, DSBackup, and Fastback, accept scratch



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diskettes if diskettes are requested, and overwrite existing files. Dump/Restore and BackTrack require clean diskettes.

Programs such as these—programs that are needed in emergency situations—should not be copy protected. Nevertheless, three of the products reviewed here are so protected: BackTrack, BAKUP, and Fastback. Fastback uses the worst possible form of copy protection from the standpoint of a hard-disk user: it requires a key disk in drive A: every time it backs up. The restore program is not copy protected.

Included with Fastback is a form to fill out to obtain an unprotected version of the program. The form contains a list of 13 promises that collectively say, "I promise not to pirate the program." Not wanting to be in the key-disk-swapping business any longer than possible, the authors sent off their form immediately. Nearly a month later, a form letter arrived explaining that the unprotected version would cost $25 more.

BAKUP and BackTrack use better copy-protection mechanisms that allow the user to install the programs directly on a hard disk. Both use a counter mechanism that permits a certain number of "installs" before the program cannot be copied further. They include an "uninstall" option to remove the program and increment the counter. But as convenient as these mechanisms sound, they still cause problems.

For example, BAKUP was reviewed on a new AT that had an unreliable 20MB hard disk; somehow, during the review, all of the installs were inadvertently used up. The documentation lists a telephone number for the user to call to receive instructions on how to get one more "emergency" install, but this call was made on the weekend and no one answered. Fortunately, BAKUP uses the standard DOS file format, so the damaged file was reconstructed using the DOS COPY command.

BUGS AND OTHER PESTS

Besides copy protection (which many software users regard as a bug), the tested versions of these programs contained a few other bugs.

BAKUP has a problem that seems to surface only when the catalog of files it maintains spans two diskettes; the problem became apparent in restoring an entire hard disk after reformatting it. BAKUP asked for the last disk in the backup set—the one that had the catalog. But the catalog was split across the last two diskettes, so BAKUP asked for the second-to-last diskette. Then it asked for the last diskette again. Finally it gave up and displayed a message to the effect that the catalog was bad.

DSBackup has a minor problem in its installation process. The product's instructions tell the user to type the word **install** followed by the name of the directory onto which he wants the program to be installed. This process works satisfactorily if the directory that is specified by the user already exists. If, however, the directory does not exist, DSBackup does not create one. During the review, all of the DSBackup files ended up copied into a single file called DSBACKUP (the name that had been given for the directory). The documentation does not discuss the necessity of creating a directory first.

Dump/Restore had difficulty dealing with bad diskettes during backup.

BackTrack has an annoying quirk: during the installation process, the program adds many lines to the AUTOEXEC.BAT file.

In the course of one backup session, the program did not like the FAT on backup diskette number 8. However, instead of requesting a different diskette, it aborted the entire backup process. To correct the problem, a different diskette had to be used and the entire backup program started over from the beginning, with diskette number 1. This cost more than 36 minutes of additional backup time.

BackTrack has a quirk that really cannot be called a bug, but it is annoying just the same. During installation, the program adds lines to the AUTOEXEC.BAT file. The documentation mentions what will happen, but the program does not give the user the option to edit the AUTOEXEC.BAT file. A user who is very careful about the contents of his AUTOEXEC.BAT will not appreciate programs fiddling around in there without his permission.

The first version of Fastback used, version 5.0, had a couple of serious bugs that begged the question as to whether this program, despite its speed, was worth considering. But version 5.02, the program used for evaluation in this article, corrected all the bugs that were found. Users with earlier versions should upgrade to version 5.02 or later.

RELATIVE COSTS

These programs range in price from $69 to $180, which is not much when compared to $1,000 and $2,000 tape backup systems. Still, in comparison to other utility software programs, they all seem a bit overpriced. If Borland International can sell SideKick for $85, Reflex for $99, and Turbo Pascal for $70, then these backup programs are more sensibly priced in the $50 range. At that price, almost every hard-disk owner should consider one.

A few of these backup utilities offer excellent performance; the most unfortunate aspect is that they are also copy protected. Certainly, the overall winner is Fastback, a program with speed and error-correction capabilities unique among the products reviewed. Fastback maintains a catalog of incremental backup disks, as does BAKUP, which also is worth considering. Though somewhat slower, BAKUP offers a nice menu-driven interface. Both are usable alternatives to hardware backup systems.

BackTrack 1.75: $179.00
Tallgrass Software Technologies
91 Sheldon Street
Providence, RI 02906
401/274-0393
CIRCLE 356 ON READER SERVICE CARD

BAKUP 3.04.2: $179.95
Software Integration, Inc.
9800 S. Sepulveda Blvd., Suite 214
Los Angeles, CA 90045
213/776-3406
CIRCLE 357 ON READER SERVICE CARD

DSBackup 2.2: $69.95
Design Software, Inc.
2 N. 520 Prince Crossing Road
Suite 16
West Chicago, IL 60185
312/231-4540
CIRCLE 358 ON READER SERVICE CARD

Dump/Restore 1.04: $129.95
Cogitate, Inc.
24000 Telegraph Road
Southfield, MI 48034
313/352-2345
CIRCLE 359 ON READER SERVICE CARD

Fastback 5.02: $179.00
Fifth Generation Systems
7942 Picardy Avenue, No. B-350
Baton Rouge, LA 70809
504/767-0075
CIRCLE 360 ON READER SERVICE CARD

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Decimal Arithmetic: Trigonometric, logarithmic functions, powers, conversion to strings, BCD operations for numbers up to 16 significant digits.

Level 0 I/O Functions: Direct operations for screen, keyboard, printer, and asynch port to minimize memory usage and maximize speed.

IBM PC BIOS Interface Access: Gets basic I/O services in ROM BIOS not available from the operating system to get and set keyboard modes, printer port status, video attributes and cursor positioning.

Terminal Independence Package for transport to other types of terminals.

Product Code: S0200 PC Brand:
List Price: **$150.00** **$109.00**

GREENLEAF FUNCTIONS

New 3.0 has 225 functions in *both C and assembler source* as well as library format. We have versions for Lattice, Microsoft, C86, Mark Wms. New emphasis on tighter functional groupings to minimize excess baggage of functions loaded whether used or not. Manual's 250 pages now help select functions, as do demos and bulletin board.

32 DOS extensions: file and directory manipulation for DOS 1.1 and 2.0.

23 Screen Functions: Select mode, page, monochrome or color, palette; cursor shape, positioning; clearing and scrolling; pixel get and put; read light pen.

60 String Functions: Manipulation of strings including center and justify; efficient list operations which add, delete, and sort pointers to strings for top speed.

50 Graphics Functions: Primitives to access all graphics; typeface, formatting, and forms control.

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Product Code: S0770 PC Brand:
List Price: **$185.00** **$139.00**

GREENLEAF COMMUNICATIONS

Want your application to communicate with other users or remote date bases? Now you can build asynchronous communications right into your C programs!

Over 60 functions *and demo programs in both C and assembler source code* set up an interrupt driven scheme with separate transmit and receive ring buffers for an arbitrary number of ports. Interrupt control means you can download a record, then halt the incoming stream to file it, display it, let the user tamper with it, send it back up line. Goodbye separate communications software.

Supports ASCII or binary, any parity, any word length, 8250 UARTs, all four Lattice C memory models, Hayes 300, 1200, 1200B and other modems.

Its 80-page manual has examples of each function and guides you through asynchronous communications.

Product Code: S0750 PC Brand:
List Price: **$185.00** **$139.00**

BTRIEVE

BEST BUY!

Queen B-Tree File Manager Abdicates Royalties

This monarch of file managers has always been off-limits to programmers for whom royalties would ruin profit margins. So it's quite a proclamation indeed that one need no long pay a tithe to incorporate Btrieve™ in applications.

Btrieve is fully developed and fast. It takes complete charge of all file indexing, reading, writing, insertion and deletion. It builds 22 commands right into the language you use in the form of functions you call to tell Btrieve what to do. The commands create, open, and close files; delete and insert records, recapturing vacated space; find records which exactly or most nearly match keys; walk files by ascending or descending key.

Btrieve's foundation is a balanced-tree indexing scheme, conceded to be the fastest search technique devised (it will find any key in a million-plus item index in four or less accesses).

Btrieve comes with interfaces to C, Pascal, BASIC, and COBOL, and the manual gives you working sample programs which demonstrate every command in all four languages. The kind of presentation which led *PC World* to exclaim "for those of us who have endured poorly written and inadequate manuals, this one is a pleasure."

Btrieve has mainframe specifications! A single file may have up to 24 indexes. Segments of keys may be indexed. Each index can independently accept or block duplicate keys. A record length can be up to 4090 characters; an index length 255 characters. A file may be 4 billion bytes. It can even extend a file across two drives — even two hard disks!

With Btrieve you are freed to think logically; the physical file is no longer of concern. Gone for good is all that time-wasting dickering with intricate file referencing schemes and sorting algorithms. Thinking shifts to a higher plane.

Product Code: S0650 PC Brand:
List Price: **$245.00** **$199.00**

PLINK86 & PLUS

Dynamic Cache Overlays Maximize Memory Use

Plink86,™ long the overlord of overlay linkers, now has a Plus version. As a linker Plink can be used with any compiled language which delivers Microsoft/Intel format object files. It yields automatic symbol tables and more memory maps than DOS LINK, but its overlay power has won its reputation as a miracle worker. Plink86 shoe-horns large programs into small memory by binding into your compiled program an overlay manager which knows how to swap modules of large linked programs between disk and shared memory space. Plink86's straightforward overlay description language allows you to describe your overlay hierarchy in a structure permitting up to 4.095 overlays stacked 32 deep.

So if your program needs large chunks of memory, you no longer forego sales to folks who have less. But if you've assumed 128k, and they have 640k, Plink86-Plus™ knows to use extra memory as cache for overlays — at full speed compared to disk swapping. It also can automatically restore a displaced overlay to which a subsequently called overlay must return, and assign library modules to either a program's root segment or overlay areas.

Plink, the programmer's choice even when CP/M™ was the poobah of computing.

Code:	Product:	List Price:	PC Brand:
S0500	Plink86	**$395**	**$289**
S0499	Plink86-Plus	**$495**	**$359**

C-SPRITE

Lattice's Debugger for Lattice C

We once called it a symbolic debugger, but Lattice® advances now bring your source code on screen for your viewing pleasure. Hand this versatile companion to your compiler a .COM or .EXE file and C-Sprite™'s source mode will display your original program statements during most operations — your function names, your variable names, your data types, and the line numbers from your source code. At any breakpoint you can disassemble the object code and see source and assembler intermingled on screen.

If inclined, you can as well view machine addresses and machine-coded instructions to scrutinize what the compiler (or an assembler) contrived. You can work with data in hex, of course, or specify C's data types to cause the debugger to display memory addresses as strings, long integers, etc., even pointers.

C-Sprite can set breakpoints using symbols or addresses. You can submit clusters of commands to be executed at the breakpoints, or set commands that execute until a condition is met. New features permit redirection of STDIN and STDOUT, display and alteration of 8087 status, the setting of pointer sizes, and a symbol table exceeding 64k.

C-Sprite even has macros. Use your source code variable names in a macro to dump the contents of entire C structures, for example. And you can debug through one of the COM ports with a second terminal so as not to disturb your program's display screen. What's more, if you link with Plink86, C-Sprite can even tackle overlays.

Product Code: L2300 PC Brand:
List Price: **$175.00** **$149.00**

BASIC_C

Use Your Knowledge of BASIC to Learn C

If you're getting the message that switching from BASIC to C would be prudent, you're about to discover that it's back to basics of a different sort. BASIC is fat with hidden functions that stripped down C just doesn't have.

Gone are all those handy string manipulators like LEFT$, MID$, STRING$, etc. In C, when you reach for even simple invocations like INPUT or PRINT — well, underlying such expressions in BASIC are bulging macros which C cannot have if it is to keep its slim profile.

But now comes BASIC_C and all your old favorites are back. Over 80 routines to open and close files, field and perform conversions on file buffers, peek and poke, print using, clear screen, "instr", on error goto. . .they're all there. Some have reworked names and syntax to suit C, but all are written as one-to-one functional equivalents to the familiar features of BASIC. And they are documented one to a page in alphabetical sequence like the Microsoft manual for added familiarity.

So with BASIC_C, when you're thinking INPUT, go ahead. Use it. Or LPRINT or LOCATE or INKEY. But without BASIC_C, you will find that every line of code plunges you back in the C texts to figure out how to write it. Someday you'll want to, but for now, BASIC_C will start you programming quickly at the statement level so that you can concentrate on C's larger concepts.

Product Code: S0350 PC Brand:
List Price: **$175.00** **$139.00**

BASTOC

Translates BASIC to C

You'd like to upgrade C, but what to do with that warehouse of BASIC routines you've carefully polished over the years? And how to face converting your famous Leviathan accounting system from BASIC, much less your Labyrinth file management package?

Use BASTOC,™ a translator which takes in BASIC source code and emits pure Kernighan & Ritchie C. Our BASTOC versions understand either Microsoft Extended BASIC or CBasic, with Lattice C as the target. They will optionally convert your program into a single monolithic C function or will decompose it into separate functions, one for each GOSUB label.

Strings are dynamically allocated in the target program, ridding your application of BASIC's catatonic halts for garbage collection. BASTOC will try to create structure of even the most convoluted BASIC code, and writes any indigestible statement into the C output as a comment plus explanation. Also, you optionally can tell BASTOC to insert BASIC source lines into the C target as comments.

BASTOC comes with a runtime library for final link-up with compiled C output. Source code of those modules which contact the operating system is supplied so you can tailor BASTOC to your environment if needed.

Product Code: S0375 PC Brand:
List Price: **$350.00** **$299.00**

PANEL

Feature-Laden Screen Design Tool

The newest version of this premier programming tool lets you layer your screen designs with up to ten overlapping images, making it easy to background a screen with pop-up lists, help boxes, and alternate sets of input fields.

Writing your own screenware is a good way to blow completion dates and profits. Panel™ works with you interactively to set up foolproof screen displays and data entry forms rapidly. It tests your form to prove that it (and test data) behave correctly, then converts the finished work into C source code for incorporation into your application. Compile with Lattice or Microsoft.

Wonderfully diverse attributes may be selected for any field — size, data type, color, of course, but also conversion of input to upper case; clearance of existing data when new entry is started; masks for standard formats (eg, dates, phone numbers); a choice of styles for numeric fields; phrases which fill in when their first letter is typed; multiple-choice lists from which to choose a field fill-in by cursoring a highlighted bar. Fields may be multi-lined (eg, name and address as one field) and scrolled if larger than the screen space allotted them.

Panel builds in a user interface for keystroke movement within and between fields, and supplies extensive validation routines for checking user field entries — in source code, so you can tack on your own unique variants. Screen designs may be dynamically loaded from file, or compiled into a program, and version 6 has optimized code to quicken display speed.

The whole package is wrapped in a monitor and keyboard customization package to tailor your application for other equipment. Panel. A superior productivity tool now bigger than ever.

Product Code: S0400 * PC Brand:
List Price: **$295.00** **$229.00**

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RUN/C PROFESSIONAL VERSION

Interpreter Now Accesses Binary Libraries

RUN/C was an innovator for converting inaccessible compiled C to an interpreted language as easy to grab hold of as BASIC. Great for learning, but a problem remained for pros An interpreter expects nothing but source code, and that put the vast resource of professional binary libraries off limits.

No longer: RUN/C Professional™ has the tools dynamically to load and unload multiple binary function libraries while in its interpreter. Your code can now reach for functions in the commercial C libraries like C-Food Smorgasbord™ - opposite— potentially any library compiled with Lattice's large model. How? The manual shows how to develop the interface to a library, using the Lattice compiler (a must!). How about your own archive of functions? No reason why not.

The RUN/C Interpreter

The interpreting engine lies at the heart of both the improved original RUN/C and the new Professional version. Its creators had the inspiration to make once formidable C behave on screen much like PC BASIC with a full-screen editor like WordStar® . Just create a program and RUN it. If it stumbles, LIST it, EDIT it, add lines, delete lines, RUN it again, fix it again. Use familiar commands like LOAD, MERGE, SAVE, FILES, even TRON and TRACE, and a free profiler.

RUN/C is ideal for rapid program development. Put up code at high speed, tinker and re-arrange, try out things devil-may-care, and let RUN/C find your typos and malaprops.

RUN/C has a treasury of functions built into the interpreter — over 100 paralleling the most used functions found in standard compiler libraries. So when and if the time comes to compile, your source code will find counterparts.

There are lots more features — system interrupts, a shell command to invoke any operating system command without leaving RUN/C, even the ability to load a preferred editor in parallel and switch back and forth.

RUN/C Standard Version

Straight RUN/C has all above but the Loadable Libraries™ docking module. It utilizes source code only, whether created by its own editor, or from any ASCII file, such as programs you've already written, or commercial libraries which supply source code.

It makes a splendid teacher. The manual has not just instructions how to use RUN/C, but its 500-plus pages provide a thorough-going demonstration of the C language itself. Every feature, of C or RUN/C, is accorded its own micro-chapter. Over 100 of these chapters are devoted to RUN/C's built-in functions, and every one lists a sample program showing how it is used. The programs are also on the disks. So as you read them in the manual, you can run them on the screen. (Needs 180k-256k recommended.)

RUN/C Professional

RUN/C Pro has every feature of RUN/C regular plus the binary library link-up and an extra level of debugging aids. They are ingeniously installed behind a built-in function, so you can call for debugging conditionally. The called function paints a menu of debugging tools to choose from, including immediate mode to display variables, single-step tracing, and changing of variables.

RUN/C Professional can tackle projects of any size. Use it as a creative front end to feed a continuous stream of source code into compiled modules. Only the source work in progress is still interpreted; the finished modules will whiz by at object speeds. It will change how you work. (320k minimum and 512k recommended to fit libraries.)

RUN/C: quite a run for your money.

Code:	Product:	List: Price:	PC Brand:
S0910	RUN/C	$120	$109
S0950	RUN/C Pro	$250	$199

LATTICE C VERSION 3.0

NEW RELEASE!

Major Upgrades to the Best Selling C Compiler

Lattice has labored and come forth with the long-awaited Version 3.0 of its top-rated compiler. A long list of enhancements, adoption of the ANSI draft standard, documentation rivaled by few, and add-on libraries matched by none in sheer quantity restore Lattice C™ to its leadership role as the C compiler to beat.

Lattice now embraces key UNIX™ enhancements which have entered the language since Kernighan & Ritchie — void functions returning no value, enumerated data types to assign stepped values to variables, the ability to pass data between structures by assignment statements. And 3.0 adopts checking of external function arguments by data type as proposed by ANSI to kill bug swarms when modules join up at link time.

The greatly expanded libraries, now comprising 325 functions(!), enable the file sharing and record locking provisions of DOS 3.1, provide a full complement of transcendentals, and a host of utilities to mimic the UNIX and XENIX™ environments.

Lattice now delivers smaller .EXE files, curing one past complaint, boasts very fast link times and a more efficient aliasing algorithm.

The compiler now defaults to the ANSI proposed standard when you need a strict mistress, but command line options tolerate straying. New options generate code to use 80186 and 80286 instructions, and the 8087 is of course sensed and utilized if aboard.

Lattice has enjoyed pre-eminence so long that developers have created far more tools to marry into Lattice C than any other compiler. Programmers now have an enormous resource of libraries and utilities to use with Lattice to speed their work. William Hunt, in his exhaustive analysis of 12 compilers in the 1/86 issue of the *PC Tech Journal* awards Lattice the only "very good" rating for add-on library availability; puts Lattice in the top three for documentation qual-quality, calling it "one of the most usable in the group"; and sums up with this all-around accolade — "a fine product to consider for the production of important applications."

Product Code: S0100 PC Brand:
List Price: **$500.00** **$299.00**

BETTER BASIC

New Version Compatible with Microsoft BASICs

If you have several thousand hours of BASIC programming under your wing, what a dilemma the great migration to C poses! BetterBASIC™ offers an ideal sanctuary. Its design principle is simple — build the most useful features of C, Pascal, and Modula 2 into BASIC, while retaining the familiarity of a language known to millions. Version 2.0 is 100% compatible with Microsoft's GW™-BASIC and IBM BASIC and BASICA. Just load old programs and run. Save, and they are converted to BetterBASIC.

BetterBASIC is big. Its hugely expanded features require 192k; your programs can go all the way to the PC's full 640k. It is comfortable. It behaves like Microsoft BASIC at the interactive level, with a full-screen editor, direct statement execution, and always poised to RUN. But it is fast. BetterBASIC is not an interpreter. It is an incremental compiler. Each line you type is compiled (and error-checked) on the spot just once, not re-interpreted over and over at run time. The Sieve benchmark runs *6 times faster* than with Microsoft

BetterBASIC has C-like structures. Gather variables of different types into a record and give it a name. Thereafter use only the structure name for file reads and writes, leading to the unmourned demise of FIELD, MKI$, CVD, LSET, etc.

BetterBASIC has "procedures" summoned by name unlike GOSUBs. Best of all, store finished procedures in compiled modules — a single copy to use with any number of future programs.

Lots of features round it out: a built-in linker for compiled modules, a cross-reference command, 32k strings, DOS and BIOS calls, recursion, and an easily used assembly language interface. Ask about these options: 8087 support module, Btrieve interface, run-time module for re-distribution.

Product:	List:	PC Brand:
S1200	$195.00	$169.00

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At the heart of the system must be the GSS-Drivers™ package, a library of interfaces between keyboards, mice, joysticks, tablets and printers, plotters, and cameras. It conforms to the proposed ANSI virtual device interface (VDI). Give it a generic request and it copes with the idiosyncracies of the devices.

Then you have a choice of tools. First, VDI "bindings" for C and other languages are libraries of primitives with which your program can build graphic images. Each binding links to Drivers to form a working unit sufficient to produce graphics.

Productivity, though, begins with the GSS-Toolkit™ series. Each — Kernel, Plotting, or Metafile — is a library which wraps the bindings for *all* the supported languages with an envelope of intelligent tools.

Kernel knows how to drive the bindings primitives to draw and color an object, store the sequential instructions, and recreate the object on its own. So powerful, a single command may represent several score lower level statements. It offers all the capabilities of level "2b" of the ANSI Graphical Kernel Systems, (GKS) spec.

Plotting has equivalent tools specializing in graph and chart generation and their captioning. Hand it apples and oranges, say "pie", and it bakes the numbers into a digestible display for screen or plotters.

Kernel and Plotting have tools to convert images they create to virtual device metafiles (VDMs), a tokenized standard for storing graphic images as data. The Metafile Interpreter reads the contents of a VDM and interprets it for re-creation on various devices, and you can cut and paste before display.

Quality software? IBM thinks so. They sell the GSS series under their own label.

Now, what about royalties? There are none as such. Buy whichever components you choose. Then, for each which will incorporate into an application, pay a premium — now or later — but only once. Once paid, you are free to create and distribute any number of applications.

Code:	Product:		List Price:	PC Brand:
GS001	Drivers		$200	$169
GS00C	C Bindings		$150	$129
GS020	Kernel System	256k	$495	$419
GS030	Plotting System	192k	$225	$189
GS040	Metafile	256k	$175	$149

One-Time Redistribution Premium: Drivers **$200**, all others **$500**.

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Compatibility: PC BRAND's standard products are designed to operate with the IBM® PC, XT or AT under PC-DOS and require no more than 128k of RAM unless indicated. Non IBM machines using MS-DOS — contact manufacturer.
Returns: Defective parts will be replaced. Products are rendered unreturnable if you open sealed envelopes containing diskettes. Otherwise, call for authorization to return a product for refund.
Payment: We honor MasterCard, Visa, American Express (no surcharge), checks in advance, or funds wired to PC Brand, c/o Chemical Bank, 126 East 86 St., New York, Account 034-016058. COD (U.S. only) for cash, money order, certified check (no fee). NY State, add sales tax. Purchase orders accepted from larger corporations and institutions at our discretion if you agree to net 30 days plus 2% a month late penalty thereafter.
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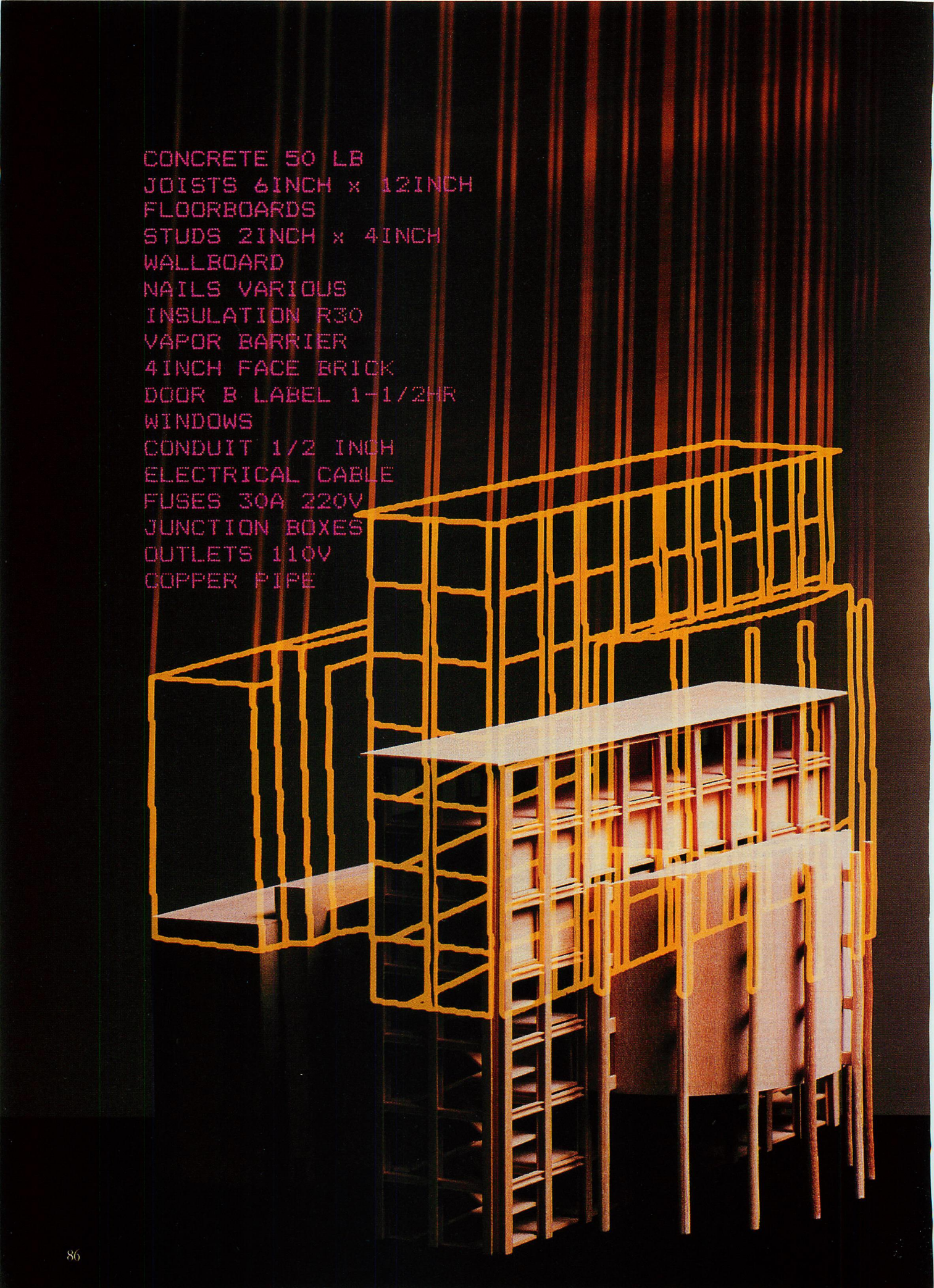
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A CADD Solution

CADVANCE takes micro-CAD systems one step closer to full CADD status by offering the database extraction features normally found on larger systems.

VICTOR E. WRIGHT

The increasing number of sales of microcomputer-based CAD packages demonstrates the success with which personal computers are able to host real computer-aided drafting systems—perhaps to the dismay of the manufacturers of larger CADD (computer-aided drafting and design) systems. One such manufacturer, CalComp, has come to grips with the micro-CAD phenomenon by buying the rights to a well-known micro-CAD package.

CADPLAN, developed by Personal CAD Systems, Inc., was the drafting component of a printed circuit board design system and was also marketed as a general purpose CAD system to architects, engineers, and other designers. In mid-1985, Personal CAD Systems sold the division that marketed CADPLAN to CalComp. CalComp's Personal Systems Unit now is marketing CADPLAN, essentially unchanged, but has added another product to the line, called CADVANCE.

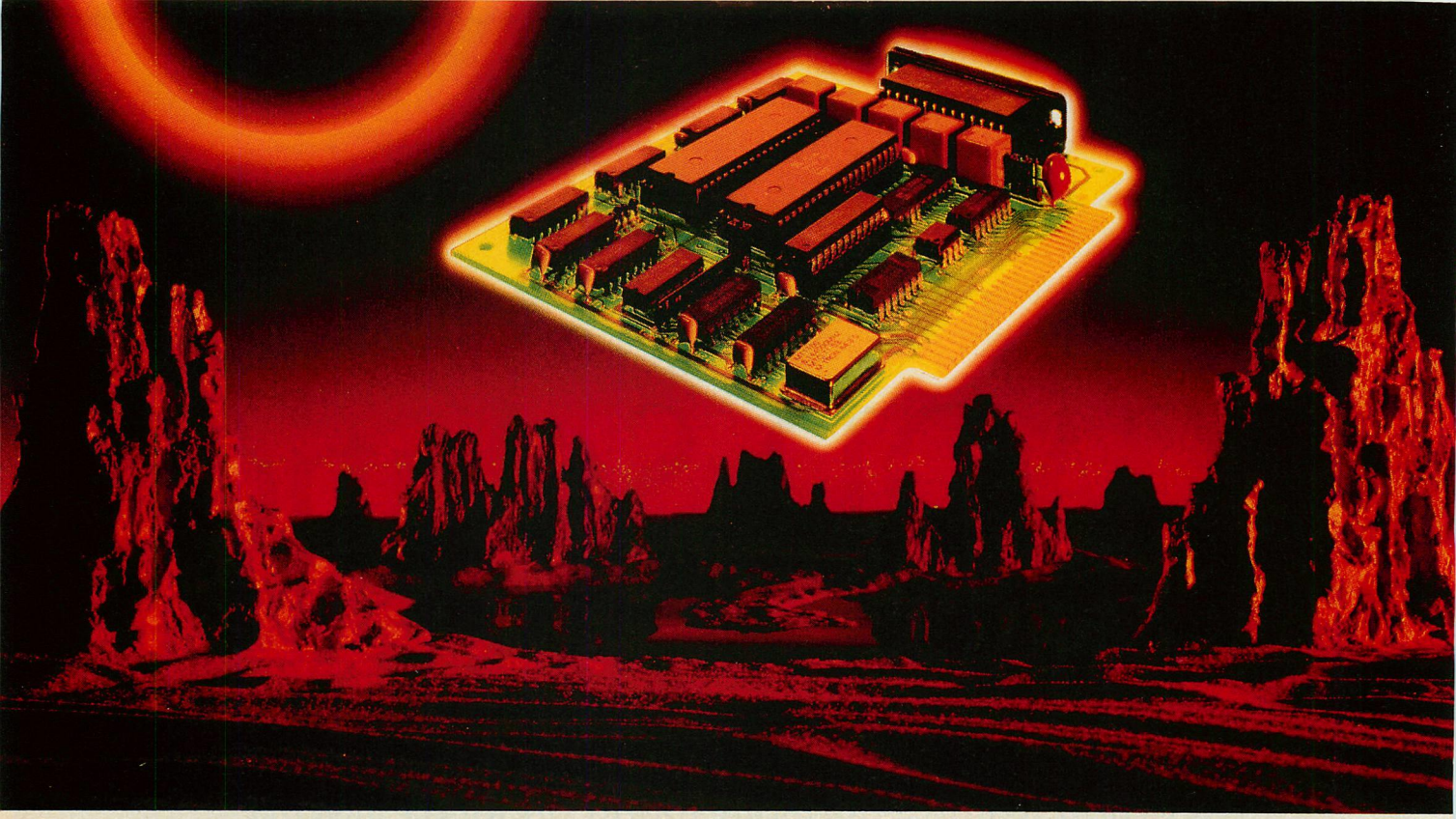
CalComp bills CADVANCE as an entirely new product and encourages registered CADPLAN users to upgrade to the newer, more powerful, and more expensive package. CADPLAN users will immediately notice a strong resemblance between the two products, as well as some significant differences.

CADVANCE can be classified as a production drafting system—that is, it has the features required for the production of working drawings, not just computer sketches, including automatic dimensioning, hatching, layering, symbols, macros, and database extraction. The program is a two-dimensional system, but can be used in conjunction with MEGA CADD's Design Board Professional (see "Three-Dimensional Modeling," Victor Wright, February 1986, p. 88), via the Design Board Link program.

CADVANCE is designed to run on the PC/XT, PC/AT, or a true compatible. The host computer must have 512KB of RAM, a serial port, a parallel port, a graphics card, a suitable monitor, and a hard disk. The program is too large to run on two 360KB floppy-disk drives.

Like its predecessor CADPLAN, CADVANCE is intended to be a menu-driven

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program, with selections entered via a pointing device or from the keyboard. A serial input device must be attached to the serial port while creating and editing drawings; both mice and digitizer pads are supported. All the plotters listed as being supported are serial plotters, requiring an additional serial port or a means to share the port between the input device and the plotter—swapping cables is workable. A buffer can be connected between the computer and the plotter; the manual lists only serial buffers.

A parallel printer can be attached to the parallel port. If the system does not have a parallel printer, the port is still required for connection of the copy-protection device, a small black box with a 25-pin connector on each end. The box can be connected between the printer and the computer or by itself. It is inconvenient if several packages with different hardware copy-protection devices are being used.

The 8087 math coprocessor IC is used, if present, for some floating-point arithmetic functions, such as the regeneration of circles.

CADVANCE uses a 16-bit integer database; this is apparent because the drawing world is 60,000 units in both the *X* and *Y* directions. The newest release of CADVANCE is expected to increase the world size to 64,000 units. An integer database provides uniform resolution over the entire drawing world, but the size of the drawing world varies with the assignment of real world units to the system's smallest unit. In contrast, a floating-point database provides a much larger drawing world, but the resolution is finer near the origin, less so toward the outer limits.

Some large systems use 32-bit integer database structures, which provide approximately 4 billion addressable points in each direction. CalComp's selection of the 16-bit format will not present a limitation to most users—with the smallest unit set to represent one-eighth inch, the system can accommodate a building that is 625 feet square, adequate for most uses of a micro-based CAD system. A machinist wishing to draw a part to an accuracy of .0001 inch, however, might not appreciate being limited to a 6-inch square. (Of course, neither the graphics display nor the plotter can produce displays with an accuracy of .0001 inch—but, if automatic dimensioning is to work, the database must include the accuracy desired in the dimensions.)

CalComp selected the 16-bit integer database for purposes of speed and resolution. The resolution that can be achieved with the 16-bit as opposed to the 32-bit integer database is sufficient for CADVANCE's supported output devices. Future versions of the package may well be based on a 32-bit integer database or a floating-point system, according to CalComp.

CADVANCE stores an entire drawing in RAM and saves to disk only on command. Thus, drawing size is limited not only in the sense that the drawing world has finite limits but also in the number of objects that can be stored in the database. The advantage of such an arrangement, of course, is that drawing sessions are not interrupted by time-consuming disk accesses.

One key to the success of microcomputer-based CAD programs is the ability to run the program on various hardware configurations, ranging from a garden variety microcomputer that can be used effectively as a word processor and spreadsheet machine to a high-performance machine optimized for high-quality graphics. If the machine is used only occasionally for CAD, low-resolution graphics may suffice, whereas high-resolution graphics may be a requirement for a machine that is dedicated to CAD work, particularly if it is used in marketing presentations.

Like its predecessor CADPLAN, CADVANCE is intended to be a menu-driven program, with selections entered via a pointing device or from the keyboard.

CADVANCE properly addresses this issue by the use of modular device drivers, all of which are included in the standard package. The manual mentions only the standard IBM Color Graphics Adapter (CGA), the IBM Professional Graphics Controller (PGC), and the Conographics Cono-Color 40 as supported graphics boards. The distribution disks, however, also include drivers for the Conographics card in a second configuration (60 Hz refresh instead of 73 Hz), the Hercules Monochrome Graphics Card, a second configuration for the CGA, the IBM Enhanced Graphics Adapter with 64KB video RAM or 256KB RAM, the Sigma 400 Graphics Card, the Artist I board, the Wyse 700 board, and the Verticom M16 Graphics Card. Available resolution ranges from 320-by-200 pixels in four colors with the standard IBM color card to 640-by-480 pixels in 16 colors, selected from a possible 4,096 colors with the PGC. The prices of the supported graphics cards range from about $900 for the standard set-up to $4,300 for the PGC. If resolution is the key criterion, the Hercules Graphics Card and a suitable monitor—the 14-inch Roland DG MB-142 white-on-black/black-on-white is impressive—is probably the best buy, providing resolution of 720 by 348.

The IBM Enhanced Graphics Adapter (EGA), with 64KB of RAM installed in its basic configuration, provides four colors at 720-by-350 pixels, comparable to the resolution of the Hercules board, but at a higher cost.

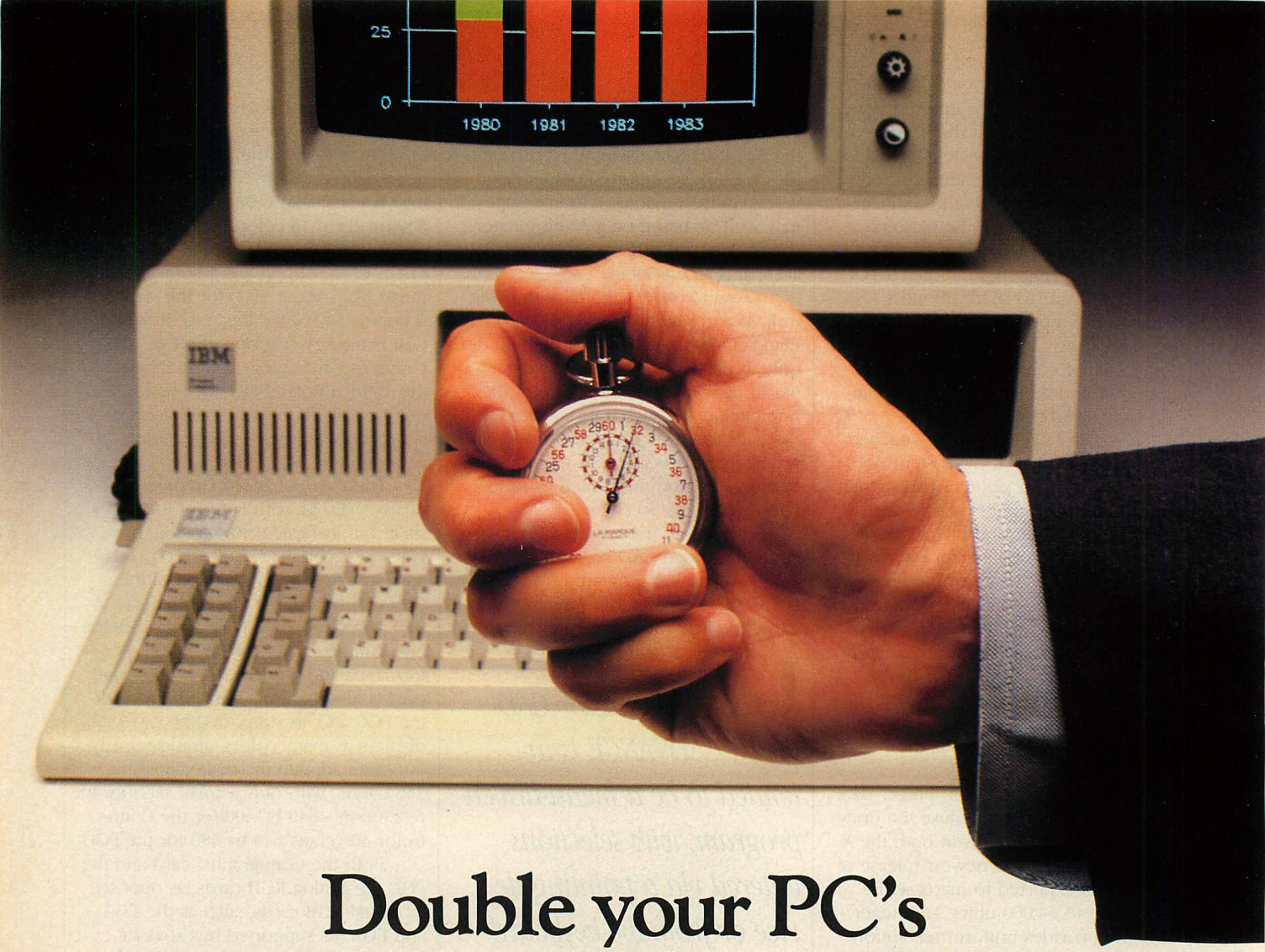
The Conographic card provides the best compromise between all-out performance and cost. The Cono-Color 40 card is less than one-third the price of the PGC and, as supported by CADVANCE, displays as many colors simultaneously, out of an admittedly smaller possible 256 colors, with only a small sacrifice in resolution—640 by 400 for the Cono-Color 40 versus 640 by 480 for the PGC.

Both the Conographic card and the PGC are analog RGB cards, as opposed to digital RGB cards, such as the CGA and EGA. As supported by CADVANCE, both require the use of an analog, long-persistence RGB monitor (the Cono-Color 40 will drive a digital monitor, but not as supported by CADVANCE). The manual recommends either the Electrohome D03101-60 or the Hitachi HM-2719B-C-11 monitor with the Conographic card, and the IBM Professional Color Display with the PGC.

The standard display—four colors at 320 by 200—may look impressive to a first-time CAD user, and the economics of a high-resolution graphics card may not seem justifiable. However, resolution of 720 by 348 for monochrome or 640 by 400 for color should be the minimal configuration.

RESPONSIVE PERFORMANCE

For this review, CADVANCE was tested on several different hardware configurations, including an XT with the Hercules Graphics Adapter; the same computer using the Hercules Color Card; a Heathkit H-161, PC-compatible, portable computer; a Heathkit H-200, AT-compatible computer with a 256KB EGA emulating the standard color card; and the EGA without its piggyback memory card (a 64KB system).



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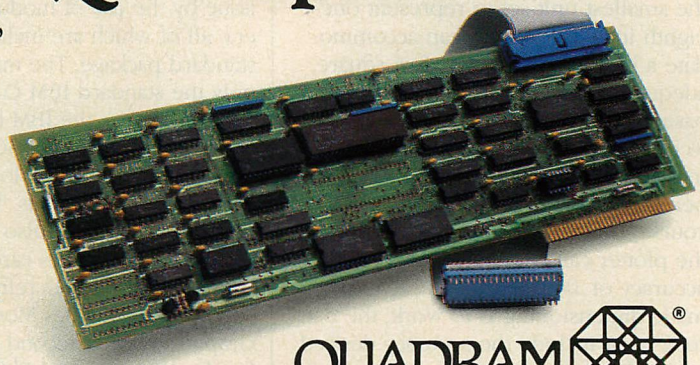
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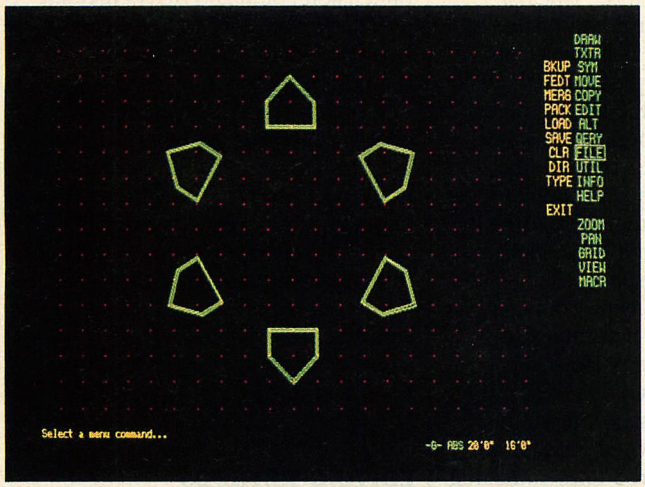


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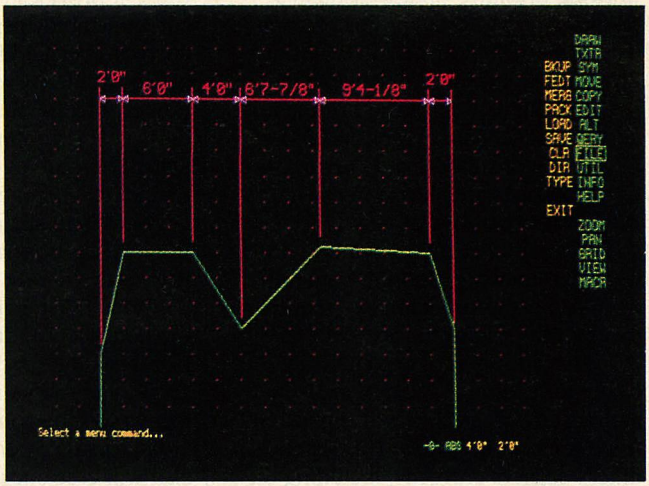
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PHOTO 1: *Screen Display*



The COPY/CIRC command copies and positions the object in a circular array. The object can be rotated or not as desired. The display shown is an EGA but the area occupied by the menu is the same as for other hardware configurations.

PHOTO 2: *Dimensioning Facility*



The dimension markers (arrows or slashes, for example) are stored as symbols. The dimension values are calculated by CADVANCE. If a vertex is moved after the dimensioning is completed, the incorrect value is not changed.

PHOTOGRAPHS • CHRISTINE ARMSTRONG/BLAKESLEE-LANE

CADVANCE is a more responsive program than its predecessor CADPLAN, based on each product's performance on the XT with the Hercules Color Card installed. The difference in response is most noticeable when dragging shapes to new locations with the MOVE command. In fact, dragging should be avoided with CADPLAN whenever possible, instead entering only the endpoints of the displacement vector.

The 286-based, H-200, AT-compatible with an EGA installed provides a considerable increase in responsiveness over the XT with the Color Card installed. (High resolution is obtained with more video memory, and more memory takes longer to update.) On the XT the user is able to move the mouse faster than the computer can update the screen, but the AT-compatible machine keeps pace easily.

CADVANCE's display with the Hercules Graphics Card was fine. In one session, however, with both the Hercules Color and Graphic cards installed in the same computer, switching from graphics to text and back to graphics made a total disaster of the display. CalComp suggested changing the number of files in CONFIG.SYS from the 15 that the manual suggests to 30. This apparently cured the problem. Of course, the Hercules cards must be initialized with the HGC FULL command issued from DOS before loading CADVANCE.

The CADVANCE screen display is divided into three general areas (see photo 1). The largest and most prominent area is the graphics viewport, where a view of the current drawing is displayed. On a standard 13-inch color monitor, this area measures about 6½ inches wide by 5½ inches high. The resolution of the viewport is a function of the graphics display hardware.

The right side of the screen is the menu area. It accommodates two columns of menu selections, each four characters long. The characters are generated graphically, not by the computer's character generator. The rightmost column is the main menu, which is always displayed and available for command entry. The left menu column displays submenus of options to the main menu commands. When the program is loaded, the submenu column is blank. As commands are entered from the main menu, the submenus appear.

The third area of the CADVANCE screen consists of a prompt line and a status line at the bottom of the screen. The status line, which is the lower of the two lines, displays the coordinates of the cursor, the type of coordinate display (absolute, relative, polar-relative, or polar-absolute), and the snap mode (off, nearest grid point, nearest node, nearest vertex, nearest intersection, and nearest point on a line). Above the status line is the prompt line, which is used to display messages and option menus for certain commands.

Command entry is accomplished by selecting commands from the screen menu—either typing them at the keyboard or using a digitizer menu if a digitizer is used as the pointing device. Commands are entered from the keyboard as keystroke sequences. The sequence must begin with the slash (/) character and consist of the first letter of a command from the main menu, followed by the first letter of an option or subcommand from the submenu. VisiCalc and TK!Solver users should appreciate this feature.

A pointing device can be used to move the cursor anywhere on the screen, and the cursor changes shape depending on its position and command status. In the graphics viewport the cursor is a small cross, but can be changed to a large cross or an isometric cursor. The cursor is a box in the menu area or the status/prompt line area. During the execution of some commands the cursor changes to an *X*.

Normally, a command is entered, then options selected, and data entered. However, certain commands can be nested. For example, the viewport of the display can be changed within a drawing command so that large objects will not sacrifice accuracy.

DRAWING PRIMITIVES

The first command in the CADVANCE main menu is DRAW, which provides 12 options for creating *drawing primitives*. The collection of drawing primitives, which is larger than that included with many other CAD programs, includes lines, parallel lines (walls), rectangles, circles, arcs, curves, text, nodes, ellipses, polygons, fillets, and dimensions. The options are actually mode specifications—when the LINE option is highlighted, CADVANCE expects only endpoints of line segments. Line segments entered in a continuous sequence are treated as a single object, and multiple

sequences can be entered without repeating the DRAW/LINE command. Each drawing primitive option displays a prompt, requesting appropriate parameters. The CIRC, ARC, and ELIP options provide several ways to specify the actual configuration of the primitive.

CADVANCE makes extensive and effective use of rubberband cursors. Accepted objects are shown in one color; rubberband displays of new objects are shown in another. Line segments are accepted as they are entered. Some objects—ellipses, for example—require two button presses for acceptance.

The provision of an option to create parallel lines (2LIN) is a feature architectural designers will especially value for drawing walls. This command miters corners correctly, including the last one if a closed figure is entered by placing the last vertex at the first one.

Line type and weight can be specified from the status line when the LINE mode is active. Line type and weight are attributes of the drawing object, not of the layer containing the object.

A rectangle can be created with the single RECT command and the input of two points—two ends of a diagonal. A rectangle is drawn with single lines; therefore, walls are more effectively created with the 2LIN option.

The CURV option of the DRAW command bears special mention, because it provides for three types of curves—cubic, B-spline, and Bezier. A curve is specified by as many as ten points. Cubic curves pass through all points, fitted so that the second order derivative is continuous. The B-spline and Bezier curves pass through the endpoints; the intermediate points serve as controls to shape the curve using the Cox and de Boor and the Geometric Bezier algorithms, respectively.

The TXTR main menu command is the equivalent of the hatching command in other packages. However, TXTR offers some features not found in many hatching commands. It will not only cross-hatch enclosed areas, but also will create textured lines consisting of line segments and/or symbols. Any currently defined symbol can be used to define a textured line. The ADD and DEL options in the TXTR command allow definition and deletion of textured line definitions on the fly.

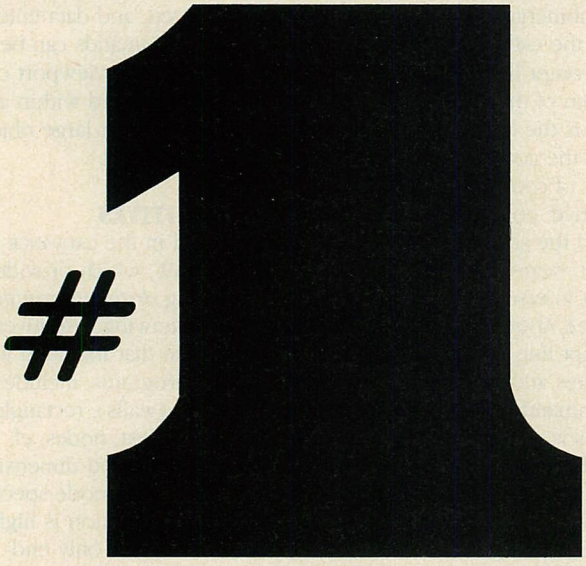
CADVANCE includes dimensioning in the DRAW command. The dimensioning feature is straightforward, but provides only the basic functions. The user can control dimension line weights, locations, markers—arrowheads, slashes, etc.—and text style. The LINE and RAD dimension commands control linear and radial dimensions, respectively. The dimension command AUTO may surprise users of other CAD programs, because it automatically creates linear dimensions between all vertices found in a search box. To define the search box, the program requests a dimension line, which must extend past the two outermost vertices, and a dimensioning depth. The program automatically creates extension lines, one extending from each vertex in the search box to a predetermined distance past the dimension line. The dimension line is trimmed at the two outer extension lines, and dimension markers and text are added (see photo 2).

EDITING METHODS

The MOVE, COPY, and EDIT commands give CADVANCE complete editing abilities. MOVE displays four methods of specifying which objects to move on the prompt line; these methods are used in other commands that require selecting objects. The first method is PNT, which allows the selection of an object by selecting a point on it. IDEN is similar to PNT except that multiple objects can be selected. The third method is WIN, which selects all objects completely contained in a window specified by two

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opposite corners. Finally, MULT is used to specify several windows.

After the objects to be moved are selected, CADVANCE requests a displacement vector. As soon as the vector's first point is specified, the selected objects disappear and are replaced by a few key points that shift as the cursor is moved. Thus, the objects can be dragged into position. Response is fast, because entire objects are not redrawn each time the shape is moved. As the shapes are moving, they are drawn as dotted lines. When movement stops they are redrawn as solid lines.

The COPY command displays a submenu of four options—ARRY, SNGL, CIRC, and MIRR. ARRY creates multiple copies of selected objects arranged in rows and columns, and SNGL makes a single copy. CIRC creates a circular array, with multiple copies of the specified objects arranged in a circle, the center and radius of which are user-specified. The objects can be rotated as they are copied (see photo 1). MIRR creates a mirror image of one or more objects, mirrored in respect to a line that can be drawn at any orientation, not just horizontally or vertically as is the case with some CAD programs.

EDIT provides 12 selections in a submenu. Objects can be DELeted, ROTated, and SCALed. Object selection is by the four options used in MOVE and COPY. EDIT also allows editing vertices—endpoints of line segments and key points of other objects. ADDV, MOVV, and DELV add a new vertex, move a vertex, and delete a vertex, respectively. The effect of these commands varies with the shape being edited: DELV can turn a rectangle into a right triangle; ADDV can transform a triangle to a diamond; and MOVV can move a circle without distortion.

A line, circle, or arc can be broken into two sections, separated by a gap, with the BRK command. Curves cannot be broken arbitrarily, but the arcs connecting the vertices can be broken. The TRIM option allows the selection of objects, the specification of a trim line that intersects the objects, and a trim side. The portions of the selected object(s) that appear on the trim side of the trim line are erased, whether or not the trim line actually extends through the entire object. This feature is similar to the clipping windows of larger systems.

The FIX option is used in conjunction with the DRAW/2LIN command to create neat wall intersections. Although DRAW/2LIN creates properly mitered corners, the additions of intersecting walls are not handled automatically. FIX cleans up cross, Y-, and T-shaped intersections, in accordance with standard architectural drafting practice. Some competitive packages require the user to execute several commands in order to accomplish the same task.

UNDO takes advantage of the fact that the DEL command does not actually remove objects from the database, but simply marks them deleted and removes them from the screen display. UNDO brings back any deleted objects within a window, first highlighting them and requesting confirmation from the user of the UNDO command.

A single or wall line can be broken and a specified symbol inserted in the break with CADVANCE's OPEN command. This powerful command accomplishes a sequence of operations that would require several commands in many other micro-CAD packages, and it greatly simplifies the task of inserting windows and doors in walls. OPEN's complement is CLOS, which removes symbols that were inserted with the OPEN command and reconnects the lines. This operation also would be more time consuming with most other CAD systems.

CADVANCE provides the usual complement of display control commands, of which ZOOM and PAN are the most frequently used. ZOOM

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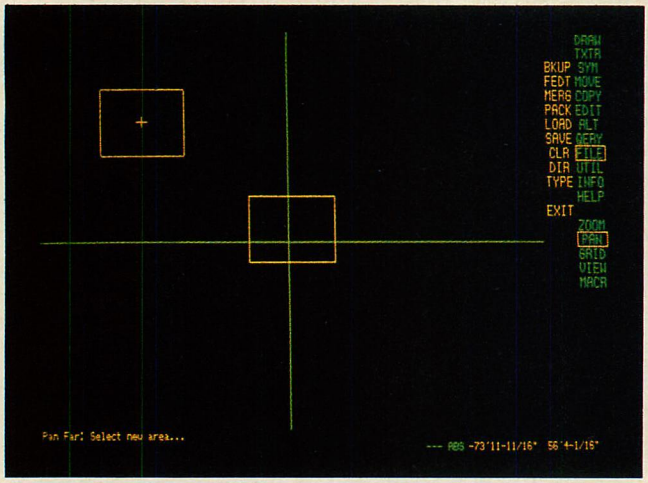
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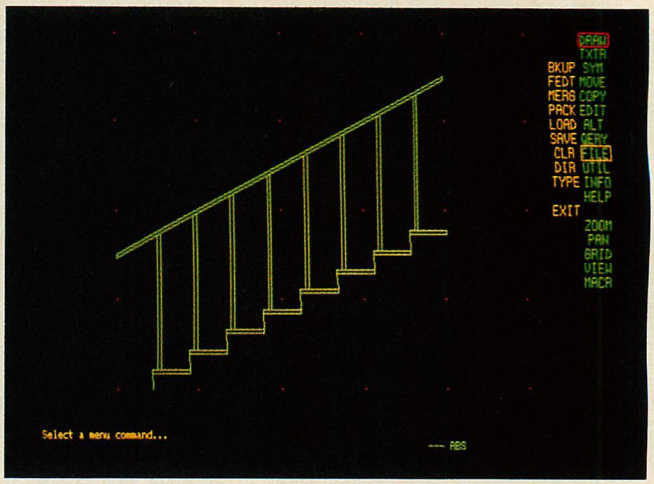
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PHOTO 3: *Windowing Facility*



The present viewport is positioned centrally in the long range view. It can be changed without affecting the scale by moving the other window to the desired position.

PHOTO 4: *Stair Macro*



The macro feature can partially or completely automate some of the design tasks. The stairs were drawn using the predefined macro by specifying eight variables.

changes the scale of the display, showing a larger or smaller portion of the drawing in the viewport.

The ZOOM command actually provides four options—IN, OUT, WIN, and BY—which are displayed on the prompt line when the ZOOM command is entered from the main menu. The IN and OUT options request a view center, which is indicated by positioning the cursor in the viewport with the pointing device and clicking the button. A drawing can be displayed in ten different scales using the ZOOM command; these scales are fixed.

The WIN option requests the entry of two corners of a ZOOM window and can be used only to ZOOM in. The minimum display scale is fixed; entering ZOOM WIN while at the minimum scale simply repositions the center of the window at the center of the viewport.

The BY option allows specification of an arbitrary ZOOM factor, in the range of .010 to 8.00. Changing the ZOOM factor changes the number of ZOOM steps available. Again, the maximum and minimum scales are fixed.

A drawing can be moved in the viewport without changing the scale using PAN. This command displays six options. LEFT, UP, DOWN, and RIGHT move the drawing under the viewport by a fixed step. SHORT requests a new view center. FAR displays the entire drawing world on the screen, with the current view outlined in the center, and a movable window at the same scale (see photo 3). By positioning the movable window with the pointing device, the viewport can be moved across the drawing world quickly.

The VIEW command allows definition and recall of ten numbered views and provides options to highlight key drawing features, such as shape vertices, symbols, and text.

The display control commands can be nested inside the DRAW commands.

CADVANCE's command to plot a drawing is buried in the main menu UTIL command. The manual devotes 20 pages to the PLOT subcommand and its options, not including the appendices that describe the configuration of the supported plotters. This extended coverage reflects the program's degree of control over the plotting process.

Most novice CAD users have difficulty with the concept that CAD drawings are created in real-world units and plotted to scale. In the manual drafting process, the scale at which a drawing is to be created must be determined in the very first step. Another troublesome concept for beginners is that certain drawing features, such as notes, dimension markers, etc., must be sized in real-world units so that they plot out at the correct size. Both concepts are the reverse of manual drafting.

CADVANCE complicates the plotting process by using two scale factors: drawing and plot. Drawing scale describes the relationship between CADVANCE's drawing units and real-world units—the largest ratio allowed is 1 to 1. Plot scale provides for a magnification or reduction factor. The scale of the final plot is determined by the product of the drawing and plot scales. The process is further complicated when CADVANCE is used to drive a CalComp 1043 plotter, which has yet another scale factor to be set at the plotter's control panel.

CADVANCE supports a variety of plotters: AlphaMerics, CalComp, Hewlett-Packard, Houston Instrument, IBM, Nicolet, Ioline, and Enter Computer (Sweet-P). The manual provides set-up information on all supported plotters, including switch settings, cable wiring, and device driver names.

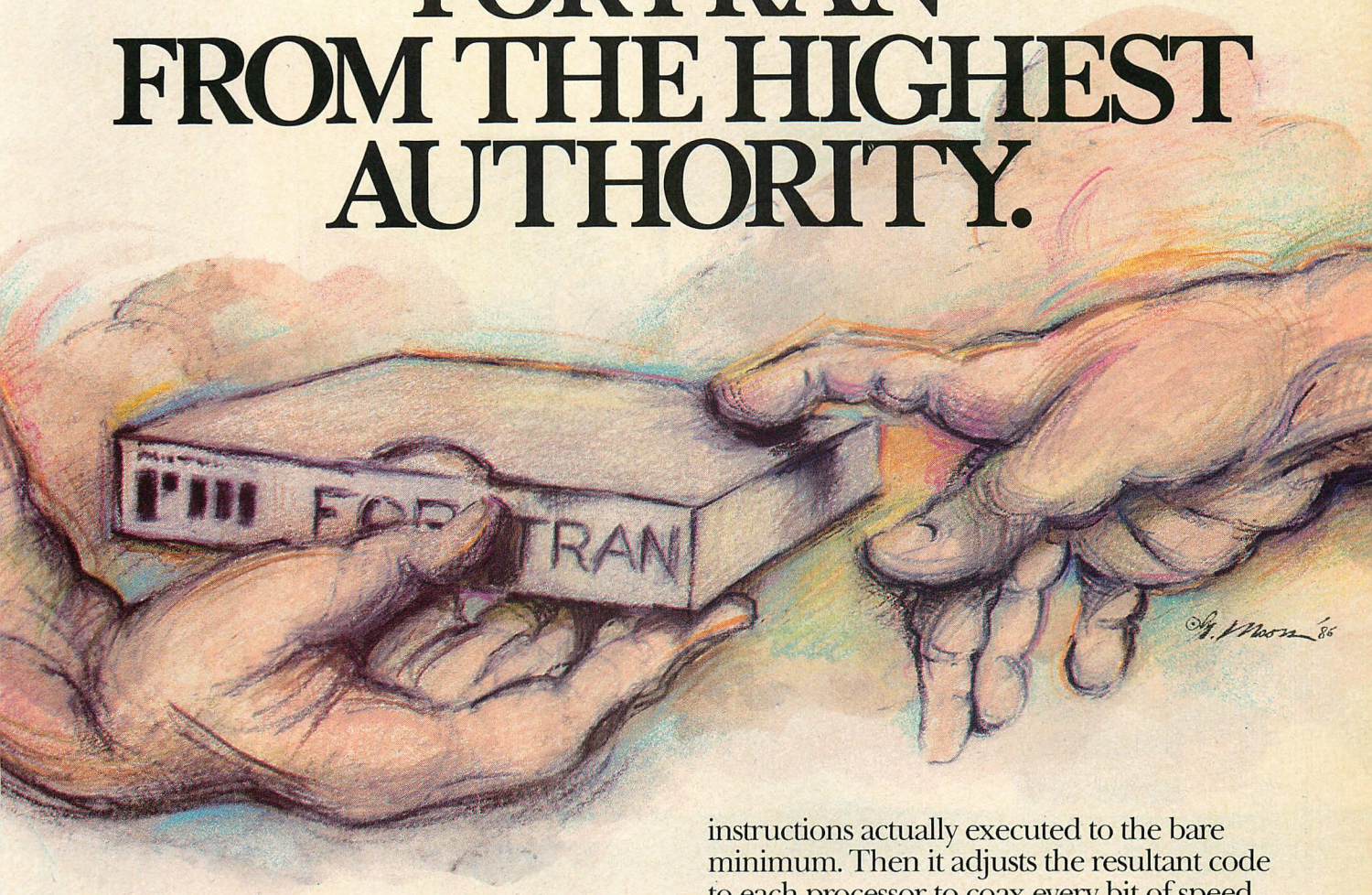
Setting up the plotter involves several steps. First, the plotter is physically connected and configured. Then the INSTALL.BAT file is used to copy the correct plotter driver file to the PD.DRV file. The plotter parameters must be set using the INFO command. Any further changes are made from the UTIL/PLOT command when the plot is made.

Plotter output can be sent directly to the plotter, to the plotter through a buffer, or to a disk file. Plotter output saved as disk files can be plotted on different shifts, different computers, or through a network.

FILE MANAGEMENT

CADVANCE has several different file types. The two most frequently used types are drawing files, which have an extension of .VWF, and symbol files, which have a default extension of .SYM. In addition, the program uses macro files, called filename.MAC by default; plot-output files (.PLT); graphic data interface files for transfer of graphic data to larger systems (.IGS); configuration information files (.CFG); font files (.FNT); and attribute data files containing symbol and layer information (.ADF). If the DBE facility (described below) is used, then .DBF, .NDX, and .BAT files are available.

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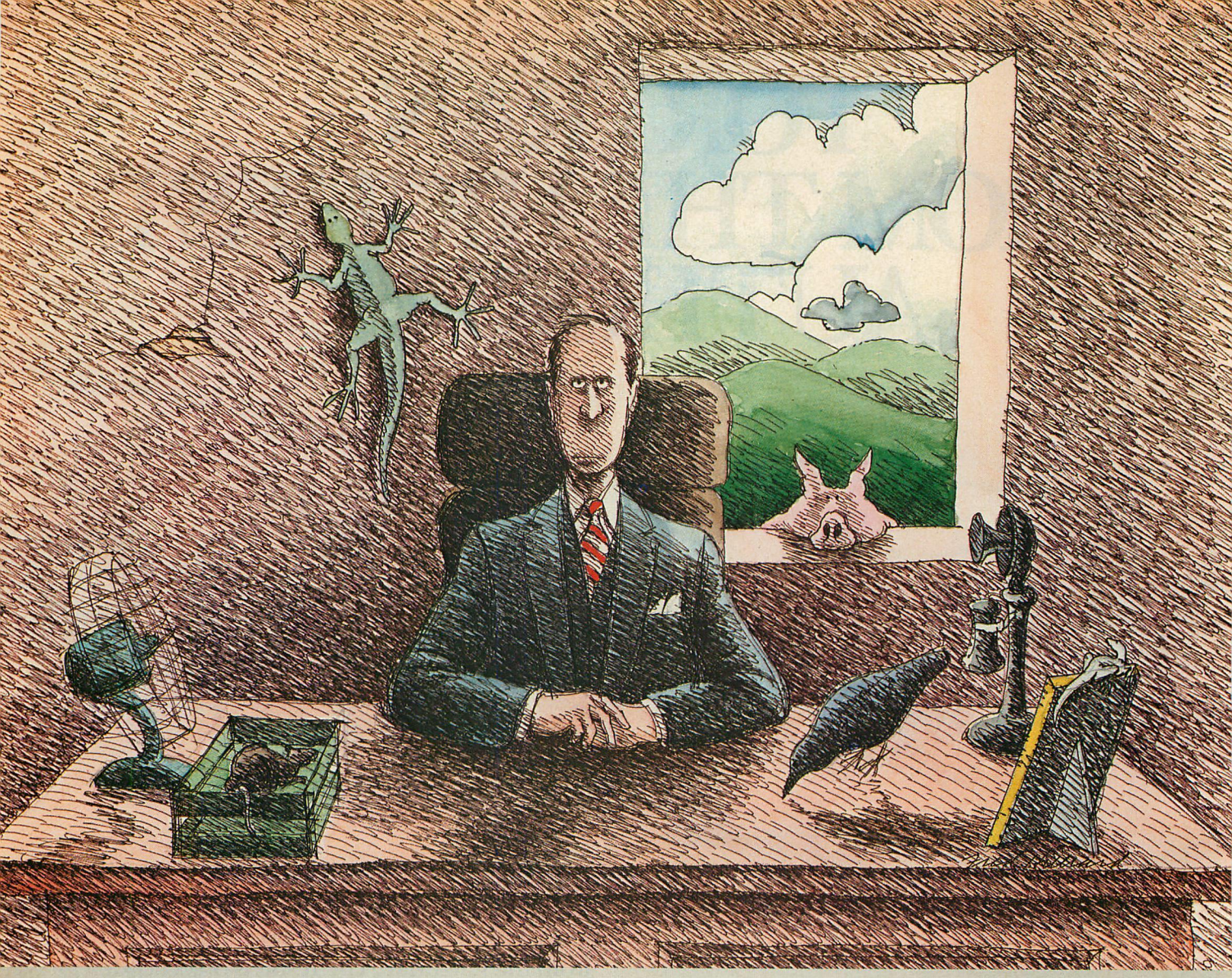
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Most file management tasks are accomplished with the FILE command in the main menu. This command provides several options: BKUP to make a batch file to write all the files needed for a drawing to disk using DOS's BACKUP command; FEDT, used to edit text files; MERG to load multiple drawing files; PACK to remove deleted items from the database; LOAD to load a single drawing file, overwriting the contents of the database; SAVE to write the drawing database out to disk; CLR to clear the database; DIR to display a disk directory; TYPE to display the contents of a text file on the screen; and EXIT to leave the program.

FEDT is a simple screen editor that could be useful except that invoking it clears the drawing database. The current drawing must be saved before beginning the editing session, then reloaded after editing is complete. The process is almost as inconvenient as leaving the drafting program in order to use an external text editor.

CADVANCE's FILE/LOAD command loads only drawing files, not font files. Changing fonts requires renaming the desired font file to CAD.FNT before starting CADVANCE. This is unfortunate, because the distribution disks include 11 font files. The latest version of CADVANCE (1.1) is expected to include multiple font capability. According to the manufacturer, as many as five fonts can be used on one drawing.

An essential feature of any CAD program that is used as the basis of a production drafting system is layering. Layers are used to organize the drawing, simplify plotting and screen display, and coordinate the work of various disciplines. The equivalent of CAD layers in manual drafting is the pinbar overlay drafting system. CADVANCE provides a total of 127 numbered layers per drawing. Each layer can be assigned a name and a color, turned off or on, and defined as selectable or not selectable—that is, layers can be left visible for use as reference layers, but protected against editing.

Layers can be assigned nongraphic attributes for use in CADVANCE's database extraction facility (described below). Therefore, the layering facility becomes a tool not only for organizing the graphic aspects of a drawing, but also for structuring nongraphic data that are associated with the drawing.

Layers are managed with the VIEW/LAYERS command, which displays a list of layers, along with assigned names, colors, visibility and selectability status, and identification of the active layer—the one in which objects are currently being entered.

The CADVANCE manual does not mention a limit to the number of objects that a layer can contain, although the overall size of a drawing has a limit. CalComp claims that this limit is greater than 100,000 objects. (In CADPLAN, layers can be filled up, at which point, another layer has to be selected to serve as the active layer.)

The ALT command in the main menu allows objects to be moved from one layer to another. In addition, ALT allows the user to change line weights and types and text styles.

SYMBOL LIBRARIES

CADVANCE allows for symbols to be created and used, a key feature for any CAD system. The program goes one step further than many CAD packages, however, and includes the facilities for symbol library management.

The CADVANCE system always stores symbol definitions on disk. They are not included in the drawing database. Instead, the drawing contains only symbol references, including the path to the symbol file. When a drawing is recalled for editing, each symbol referenced in the drawing is also loaded. Thus, if a symbol is altered, its new def-

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inition is used the next time a drawing referencing it is loaded.

Symbols can be created at any time using the SYM/MAKE command. This command asks for the objects that will compose the symbol and then for the basepoint, or the point that will be used to locate future references to the symbol. Finally, the program requests the path to the symbol file and the symbol file name. The path is displayed as a number from 1 to 8, but is defined as a normal DOS path name using the INFO command. Therefore, new symbols can be stored in predefined directories by selecting the path number.

When a symbol is first defined, it becomes the default symbol name for the SYM/PLAC command, which inserts symbol references in the drawing. As with the DRAW commands, the symbol command options are more like modes than commands. When SYM/PLAC is invoked, the last symbol inserted becomes the default symbol, and new references can be inserted quickly by using the pointing device. All the symbols referenced in the drawing can be listed with SYM/LIST, which switches the drawing to a text display. The default symbol is highlighted in the list of symbols and can be changed by moving the highlight with the pointing device.

Listing the symbols available on disk but not yet referenced in the drawing is accomplished with the SYM/DIR command. Again, the default symbol for the next reference insertion can be set by clicking the desired symbol file name on the listing. The LIST and DIR options relieve the user from remembering the symbol names exactly.

The REPL option changes a symbol reference from one symbol definition to another. With REPL, a drawing of a computer system board layout based on 64KB memory chips could be modified to show 256KB chips with a single command. REPL operates on all symbols in a window that match the name that is furnished by the user.

Because CADVANCE does not make its symbol definitions a permanent part of the drawing database, one instance of a symbol cannot be edited without affecting all other occurrences of that symbol in all other drawings. CADVANCE does, however, provide a straightforward method to edit a single instance of a symbol. Any symbol reference can be replaced with the elements of the symbol definition, using the SYM/XPND command. Once a symbol has been expanded, it can be edited as can any other group of drawing primitives.

The last option to the SYM command is COUN. It allows the user to switch to a text screen and display a list of symbols included in the drawing, along with a count of the references.

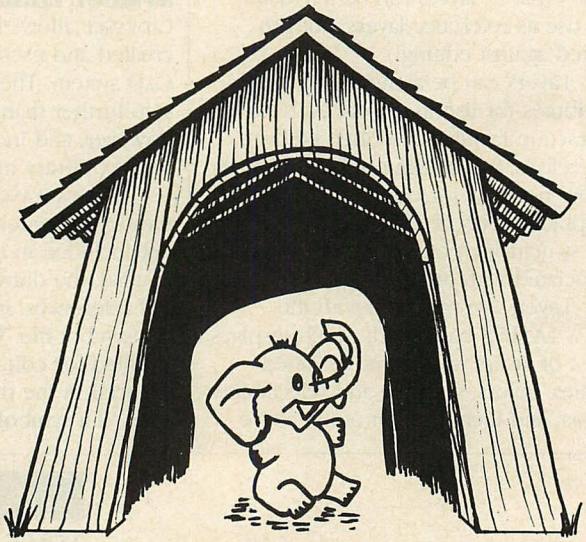
MACRO FACILTIY

Several leading CAD packages provide programming facilities so the user can write routines to customize a system. The symbol library, containing commonly used symbols with meaningful names, allows some customization. Certain situations, however, require not standard symbols, but standard sequences of events, or procedures.

Drawing stairs is a standard procedure. Three variables determine the configuration of the stairs: the height of the riser, the top surface of the step, and the number of steps. These variables determine the horizontal length of the stairs, the overall height of the stairs, and the angle of the stringer that carries the treads. People expect stair steps to be about 7 inches—6¾ to 7¼ inches is a good range. A difference of an inch between one step and another can be a tripping hazard.

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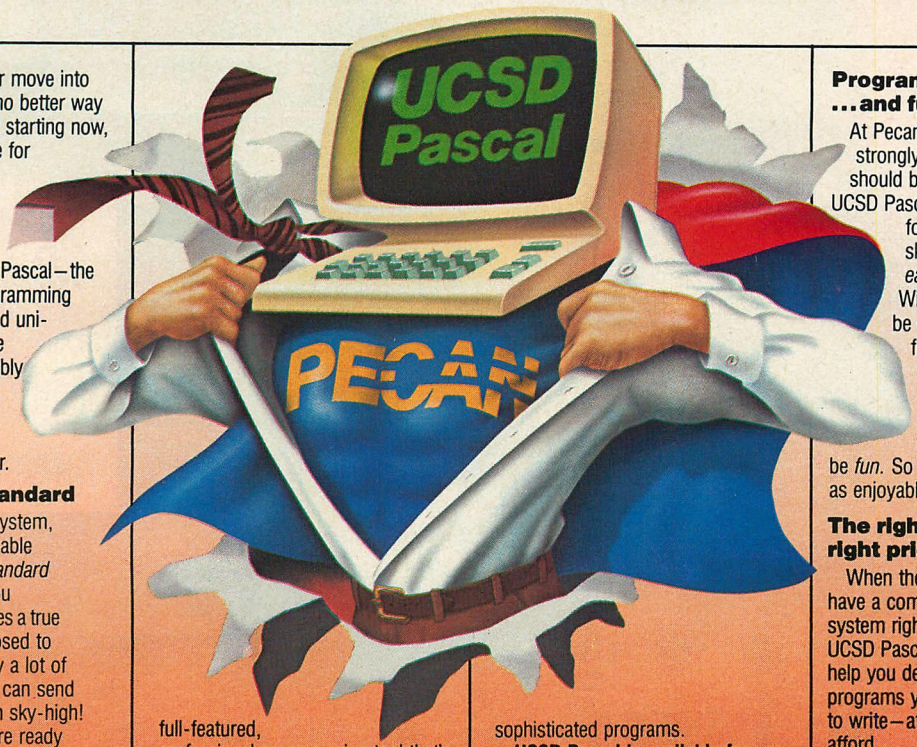
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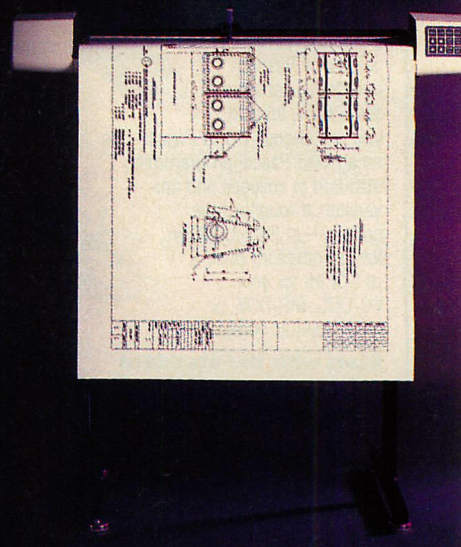
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A reasonable procedure for laying out a staircase is as follows:

- Determine the overall height—from floor to floor or floor to landing.
- Divide the overall height by 7 inches to arrive at the number of steps.
- Round off the number of steps to an integer value.
- Divide the overall height by the integer number of steps to obtain the exact height of a riser.
- Multiply the number of steps by 11 inches to obtain the overall horizontal length of the staircase.
- Adjust the overall length if necessary and divide the adjusted length by the number of steps.
- Divide the overall height by the overall horizontal length and take the arctangent to determine the angle of the stringer—check angle for code or safety procedure compliance.

This staircase example represents sequences of operations that can easily be programmed, but that are inappropriate for inclusion in a CAD system as built-in commands. A system including such features would become unwieldy because of the number of commands it would incorporate; furthermore, such a system would be overly specialized for effective marketing.

A CAD program that handles only primitive objects would not relieve the designer of much work in the task of laying out a staircase. Nor would a symbol handling feature be of great help unless the library included several symbols, each with a different number of steps, and could insert symbols at independently variable *X* and *Y* scales. Still, arithmetic would be required to determine the number of steps.

CADVANCE provides a macro facility to this end and devotes more than 50 pages of the manual and several appendices to its coverage. A macro is simply a sequence of legal CADVANCE commands and macro programming language (MPL) expressions and functions. The manual posts a warning that some general knowledge of programming is required to use MPL. However, it seems to be quite straightforward in comparison with general purpose programming languages or with macro facilities of other programs—CAD, spreadsheet, etc. And, like other macro facilities, this one requires thorough knowledge of the program's operation.

Macros are invoked with the main menu MACR command, which displays four options on the prompt line: BEGIN, END, RUN, and KEY. MACR/RUN invokes a macro. CADVANCE includes 11 macro files that illustrate various points of macro programming. Some are interactive, requiring user input; others are one-word replacements for command sequences. One example addresses the stair problem. It prompts the designer for the maximum rise per step, maximum horizontal overlap, stair width (tread depth), stair (tread) thickness, minimum rise, handrail height, the bottom point, and top of landing. It computes the step rise and requests verification that the rise is acceptable. If the rise is accepted, the program draws the steps, handrail, and the front edge of the stringer, leaving the sizing of the stringer to the designer (photo 4).

The stair macro is stored in a disk file called STAIR.MAC, which is read each time the macro is executed. Thus, the system can be extended with a large number of macros—with no sacrifice in drawing database storage. The actual code for the stair macro is 110 lines long and requires a minute or so for execution, depending on the speed with which the user supplies input. The same process performed manually could take as much as an hour.

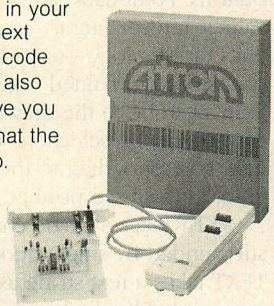
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Macros can be nested within other commands if they consist only of commands that can be nested; the display control commands also can be nested within the execution of a macro. For example, if one of the data points required by the stair macro is off the screen, the ZOOM, PAN, or VIEW command can be used to change the display to the user's specification.

A macro file consists of command lines, each beginning with a key word from a set of 17 commands. All key words, except one, are followed by arguments that can be text strings, variable names, register names, expressions, and labels. Two basic branching constructs are available: GOTO...<label> and IF...GOTO...<label>. Structured programming adherents may look upon such inelegant facilities with disdain, but these lowly constructs—unconditional branch and conditional branch—are equal to virtually any programming task.

The first four Event key words—MENU, PNT, KEY, and TEXT—correspond to the types of input the program accepts in its normal mode of operation. MENU takes an argument from the list of commands on the main menu or a submenu. For example, a macro named WALL might include the lines:

```
MENU DRAW
MENU 2LIN
```

The effect of selecting MACR RUN WALL would be the same as picking DRAW/2LIN from the screen menu.

PNT takes a point argument—Cartesian coordinates—as if the point had been picked with the pointing device, preceded by a button number, corresponding to the first and second mouse buttons. Point data can be constant values, integer literal—to use the manual's terminology—or variable, using data stored in named register variables. Points can be in the drawing viewport, or they can be selections on the prompt line, corresponding to the options entered from the prompt line.

KEY takes a single character input, surrounded by single quote marks, and TEXT takes a text string as an argument, surrounded by double quote marks.

The second group of key words, called Internal key words, consists of 13 commands that are further divided into four groups: SET, GET, cursor control, and execution control commands.

The SET command assigns values to the register variables mentioned above. These register variables are predefined. One hundred integer registers are available for general use; 100 integer registers for *X* coordinate data; 100 integer registers for *Y* coordinate data; 100 floating-point registers for general use; and 10 character string registers for general use. The manual states that the integer registers are implemented as four-byte registers. However, CADVANCE's drawing database is evidently limited to two-byte values for *X* and *Y* coordinates, because the drawing world can be only 60,000 units in either direction.

SET is the command that allows macros to perform calculations on user input and feed the results to other commands. The stair macro, for example, includes 47 SET commands, just under half of the total number of executable statements in the macro.

The argument to a SET command is a register name followed by an assignment sign (=) and an operand, which can be a literal value, another register name, or an expression with operators and multiple operands.

Expressions in a SET command argument can include the traditional arithmetic operators, such as +, −, *, /, and % (modulus or remainder operator for integer division only). No surprises are evident here; traditional operator precedence applies.

In addition to operators and operands, expressions also can use special functions. These functions, all beginning with the @ sign, à la VisiCalc, can do type conversions, find minimums and maximums, perform trigonometric functions, and take square roots.

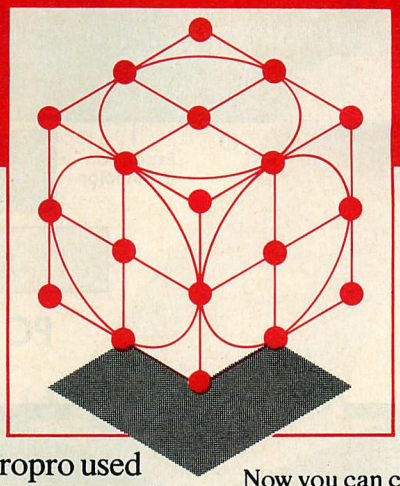
Five key words are used to obtain data from the user, all beginning with GET—GETI, GETU, GETR, GETS, GETP. These commands get integers, unit-integers (integer values that are in the currently defined units, such as feet and inches), real numbers, strings, and points, respectively. The syntax for each command includes a prompt, which CADVANCE displays on the prompt line when the command is encountered. The syntax for the first three commands includes a maximum allowed value and the register (or registers) in which the user's input will be stored.

The cursor control key words configure the cursor for operations, such as dragging and rubberbanding. Dragging is indicated by a dragging box surrounding the object(s) being dragged, and the rubberband cursor is a line connecting a previously entered point with the point being entered. Normal interactive commands, entered with the pointing device, use rubberbanding or dragging cursors, but MPL allows both.

The last group of key words includes the execution control com-

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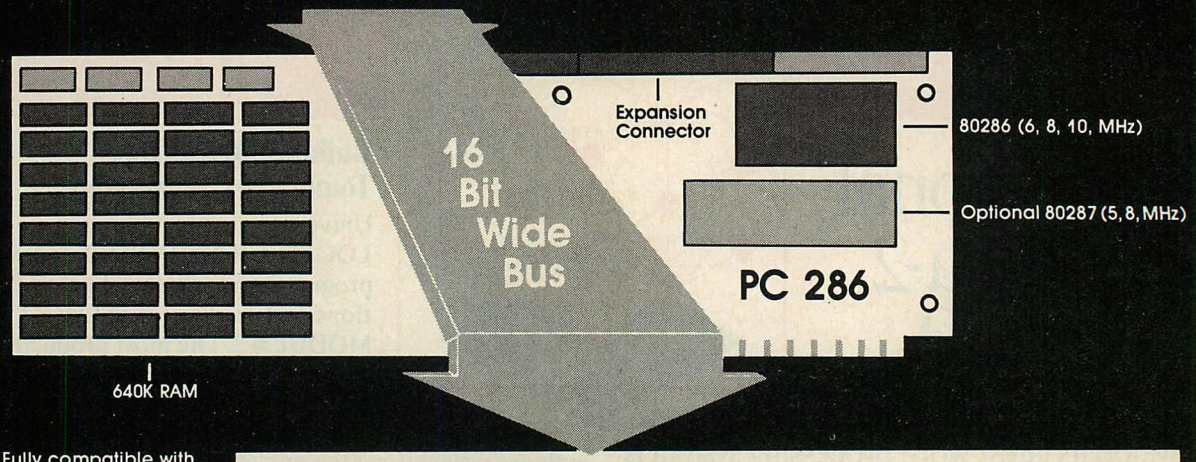
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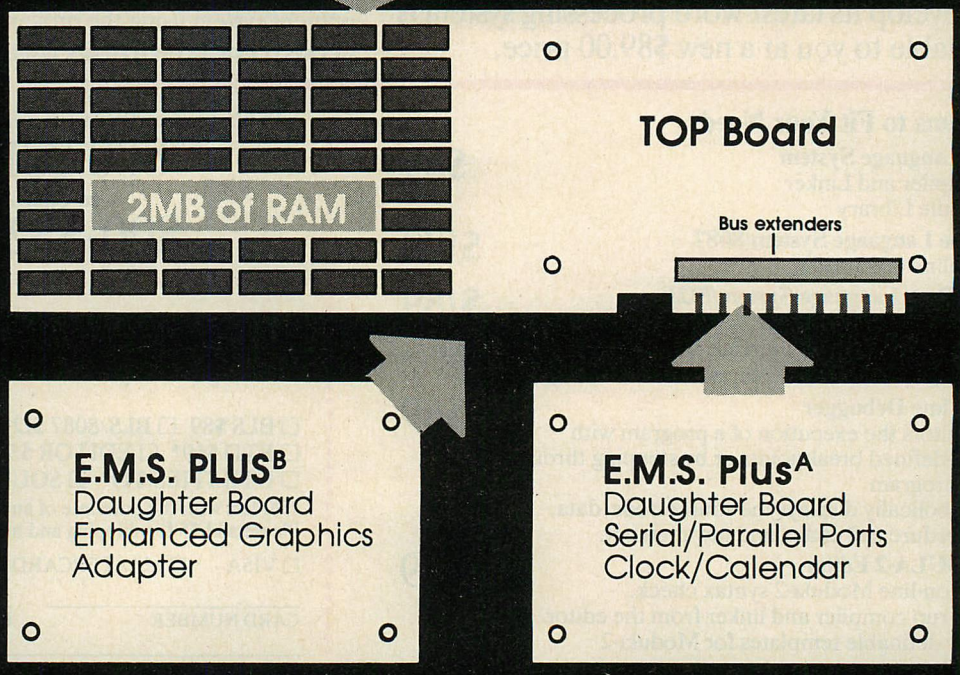
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mands, LABL, GOTO, IF...GOTO, EMSG, and EXIT. These make MPL a programming language. LABL defines the location of a label, which is the target for a GOTO statement. GOTO <label> causes an unconditional branch to the line, LABL <label>. IF <logical expression> GOTO causes a conditional branch to LABL <label>—a logical expression is an expression including one of the logical operators, EQ, NE, GT, GE, LT, LE, all familiar to FORTRAN and BASIC programmers. EMSG defines error messages. An EMSG statement will normally be preceded by a LABL statement and followed by a GOTO statement. EMSG displays an error message on the prompt line and waits for the user to press button 1 on the pointing device. When the button is pressed, the next statement is executed—the GOTO statement that returns control to the statement preceding the one that caused the user to make an error.

The MENU key word allows invocation of any command or option that appears in the two menu columns, and the PNT command allows selection of options in the prompt line. However, 31 operations are invoked from the status line—setting the active layer, setting the snap mode, setting text parameters, etc. These operations are performed with the OPC (operation code) key word, in conjunction with the PNT, TEXT, and KEY key words. As with the PNT key word used to set prompt line options, this feature requires intimate knowledge of the status line displays.

CADVANCE's macro facility is powerful enough that its design functions are limited by the user's imagination, not by any limititations of MPL itself. The combination of interactive macro definition and disk storage provides the ability to create large macro libraries, with no effect on drawing storage. Because macros are stored in text form and are interpreted, they do not execute as fast as CADVANCE's built-in commands. However, the speed of execution should not be of any great concern.

DATABASE EXTRACTION

Early microcomputer-based CAD systems incorporated drawing databases that stored only the data required to display the drawings on the screen and to plot them on the plotter. Large CADD systems, on the other hand, provided the user with the ability to attach nongraphic data to drawing objects and to generate various reports based on those nongraphic data.

The ability to manage nongraphic data is one of the two essential features that make a CAD system eligible for consideration as a CADD system (a macro programming feature is the second). CADVANCE provides this facility in the form of an external program called DBE (for database extraction).

Database extraction depends upon the assignment of attributes to symbols and layers and the assignment of values to attribute-symbol instances. Therefore, a symbol for a light fixture might be assigned the following attributes: WATTS, NO_LAMPS, VOLTAGE, NIGHT, MODEL_NO. A particular instance of that symbol might be assigned the values, 160, 4, 208, yes, 4FR880. None of this information is required to draw the light fixture symbol, but it is all quite relevant to the design.

CADVANCE allows the assignment of attributes to symbols, but not within the drafting program. All database management functions are performed in the DBE program, except for the UTIL/DBE command, which scans the drawing database to produce an attribute data file (*.ADF). The .ADF file is an interchange file used to transfer data from the drawing file (.VWF) to an attribute database file (.DBF), which is used by the DBE program to produce reports. Assignment of attributes is similar to the construction of a dBASE II/III database.

The DBE program is invoked directly from DOS. A command line at the top of the screen displays DBE's commands: LOAD, EDIT, APND, DELE, UDEL, LIST, FIND, EXTR, MAKE, INDX, PACK, REPT, and EXIT. Most of the commands are analogous to dBASE II/III commands and are executed by moving the highlight to the desired command and pressing Enter. Alternatively, commands can be executed by pressing the slash (/) key and typing the entire command, not just the first letter as is possible in the drafting program.

A database file structure is created with the MAKE command, which is similar to dBASE II/III's CREATE command. The first two fields in the file are evidently reserved for symbol names and quantities, respectively. Any remaining fields are used to store attributes attached to the symbols.

Attribute values are assigned via the REPT command, which displays a submenu of five commands. The REPT feature provides a JOB file facility similar to that of a dBASE II/III command file. The three basic JOB files are Report, which controls the format of printed or displayed reports; Index, which controls the generation of index files from database files; and Calc, which fills attribute fields with data calculated from the con-

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tents of other fields. A fourth JOB file, the DBE Batch file, controls the execution of the three basic JOB file types.

A report can be created from a drawing is the following way:

- A drawing is created incorporating symbols for objects to which nongraphic attributes are attached.
- The UTIL/DBE command creates an .ADF file, which contains the quantities and names of symbols referenced and layers defined in the drawing.
- DBE is invoked after the user exits the drafting program.
- The user creates an empty database file, with a structure that includes a field for symbol names, one for quantities, and any other attributes of interest, using the DBE MAKE command.
- Records are appended to the empty database file using the DBE APND command. One record is appended for each symbol referenced.
- The count field of each record is updated with the EXTR command, which reads the ADF file created from within the drafting program.
- The user creates Report, Index, and Calc JOB files in order to control the calculation of attribute field values and a DBE Batch file in order to control the execution of the Report, Index, and Calc files.
- The user executes the DBE Batch file, producing the report.

CADVANCE's DBE facility can perform inventory tracking, facility planning, and material takeoff for cost estimating. The system can accomplish three basic tasks from within the drafting program, from which considerable additional information can be derived using the DBE program. The system counts symbols by name, accumulates the length of lines on a layer, and calculates the area of each window defined. These tasks can be performed for the entire drawing or for multiple windows.

Given symbol counts, equipment and devices can be priced. Given line lengths per layer, material can be priced on a per length basis. Further, given the area of a window, total costs can then be converted to cost per square unit, and unit area costs can be extended to total costs.

Although the DBE facility adequately performs the basic tasks of nongraphic database management, some users will wish to perform more complex tasks or use the database in a more interactive manner. Because the DBE files are in dBASE II format, complex processing tasks can be handled with dBASE II programs. Alternatively, the nongraphic database can be designed with dBASE II and only the extraction from the .ADF files to the .DBF files need be accomplished with DBE.

In fact, almost any program that uses dBASE II file formats should be usable with the DBE files. The interactive tasks can be addressed with Lotus 1-2-3, using the 1-2-3 translator program to translate the .DBF files to Lotus .WKS files. Then, the database can be massaged in spreadsheet form.

The DBE facility is not without some limitations. Because nongraphic attributes cannot be defined within the drawing database, but must instead be defined in external database files, symbol instances cannot be assigned various attribute value pairs. That is, a symbol for a chair may be assigned a COLOR attribute and a value of RED for that attribute in the .DBF file. However, the same CHAIR symbol cannot be assigned another color. Only the number of instances is exported from the drawing database file for use with the DBE facility. Thus, in order to use DBE for interior design as well as for facility management, the symbol library must include not just one symbol for chairs, but several symbols—RED-CHR, BRN-CHR, GRN-CHR, etc.

Nevertheless, the ability to extract line lengths by layer is a powerful fea-

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ture. It allows users to make quantity takeoffs of any type of material that can be measured in linear units. The most likely limitation in this connection is the number of layers. In order to perform a completely automatic takeoff of electrical wire and conduit, for example, a layer would be needed not only for each size of conduit, but for every combination of conduit size, conductor size, and number of conductors in a conduit. A large building with conduit sizes ranging from ¾ inch to 3 inches, wire sizes from 14 AWG to 3/0 (or larger), and from 3 to a dozen or so conductors per conduit run would quickly exhaust the 127 layers available. The other limitation is that electrical designers normally do not draw all conduit/conductor runs, only main feeder runs and enough branch circuit wiring to illustrate circuiting—with "home runs" indicated schematically.

The newest version of CADVANCE makes the database interchange facility separate to the main program and has to be purchased separately to CADVANCE.

SUITABLE PRODUCT

CADVANCE is suitable for production drafting, with the exception that the integer drawing database structure, currently limited to 16-bit coordinates, may force a trade-off between drawing size and resolution in the database. The plotting facility is excellent, as it should be coming from CalComp, and drawing production is paramount. For a newly introduced package, CADVANCE supports a fairly wide variety of graphic peripherals, and CalComp has indicated it intends to expand that support.

The documented programming language MPL provides users and third-party vendors with an effective means of customizing the package for specific disciplines and fields. MPL can speed the execution of repetitive tasks and automate some design tasks related to the drawing process. However, the lack of a custom menu facility detracts from the potential of MPL. CADVANCE would be much more attractive if custom menus could be displayed on the screen. The integration of command menus into the basic program structure complicates a third-party vendor's efforts to customize the program so that the vendor's enhancements are obvious. The only interface to the enhancements is through the SYM and MACR commands. The menu is still obviously CADVANCE. Whether third-party vendors rally to CADVANCE remains to be seen.

The Database Extraction facility endows CADVANCE with database management and report generation features that are normally associated with larger systems. Because the DBE program is based on the dBASE II file structure, users and third-party vendors are able to extend the database management side of the program. The choice of the dBASE II database file structure provides a means of exporting drawing-related attributes to a large number of other programs—for the performance of tasks CADVANCE cannot handle.

The product seems to owe at least part of its heritage to Personal CAD System's CADPLAN, even though CalComp maintains that CADVANCE is a completely new program. Nonetheless, CADPLAN users looking for an upgrade should welcome the resemblance between the two programs and adapting to CADVANCE will be relatively painless.

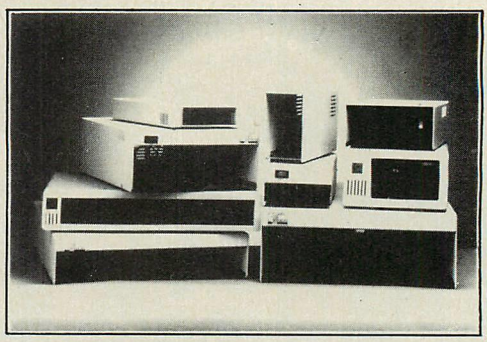
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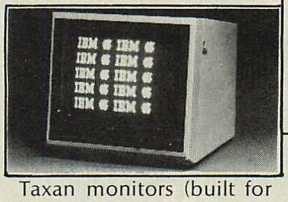
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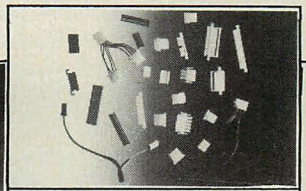
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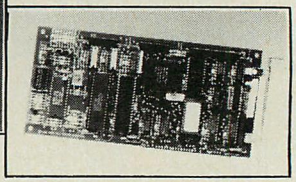
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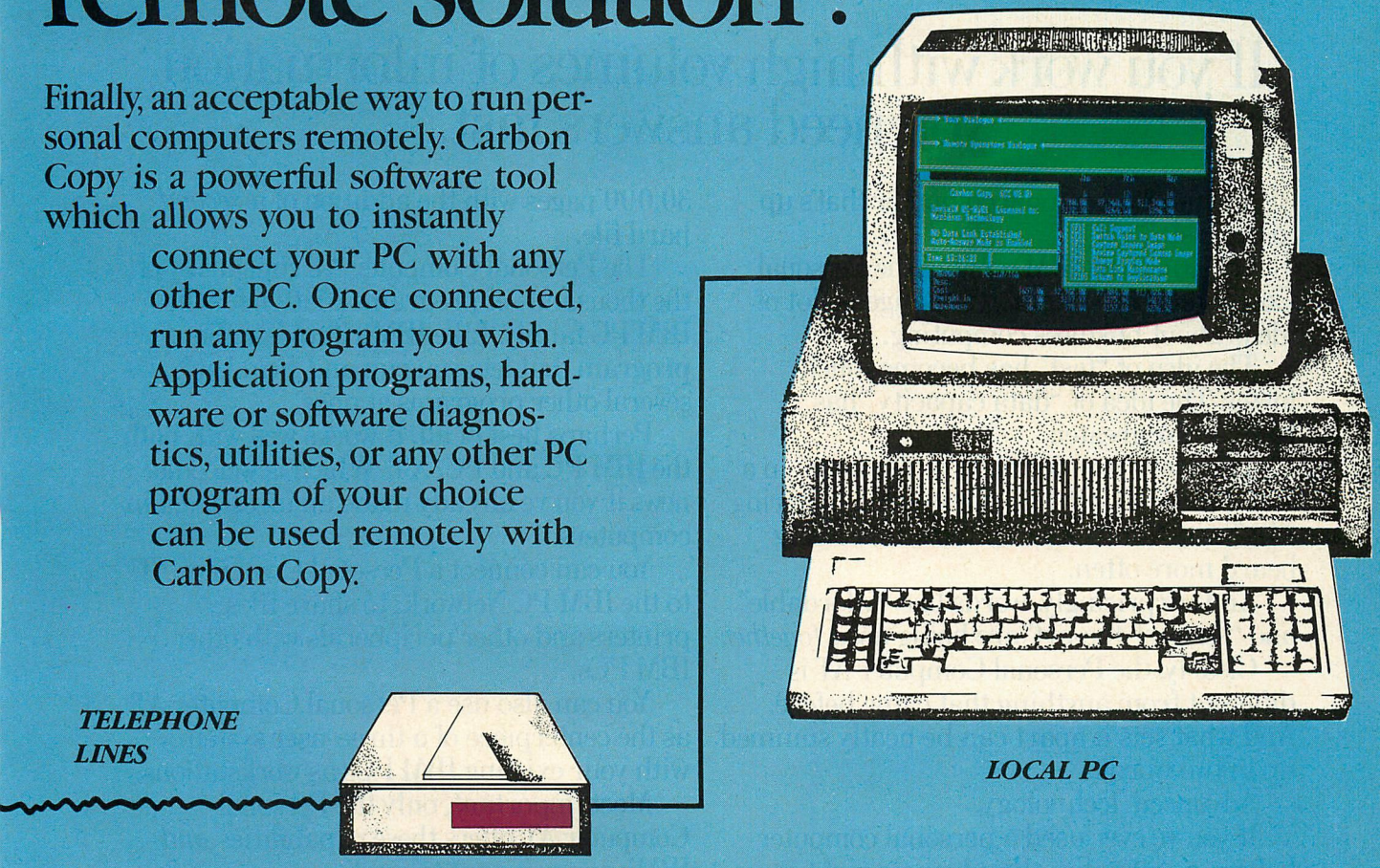
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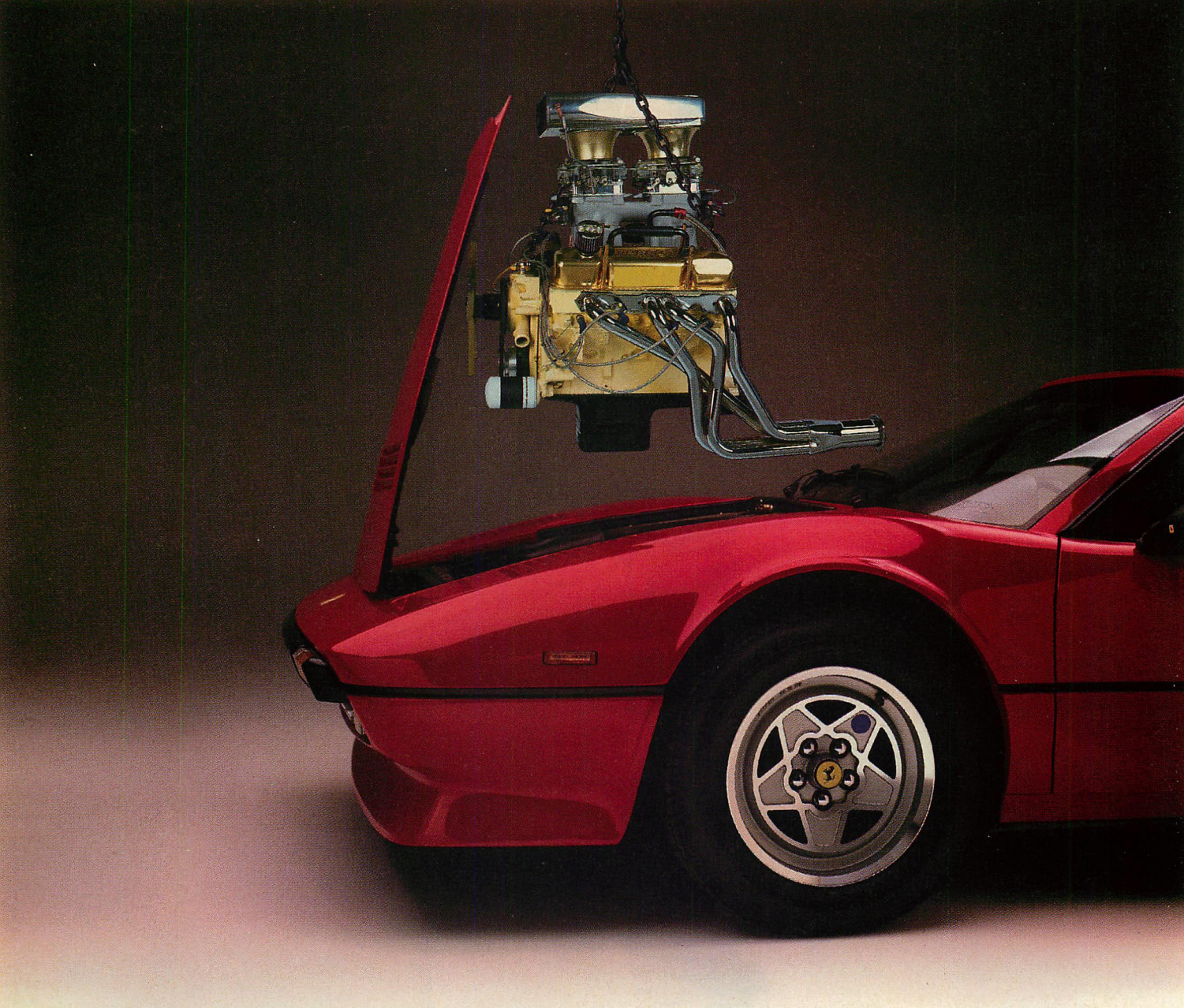
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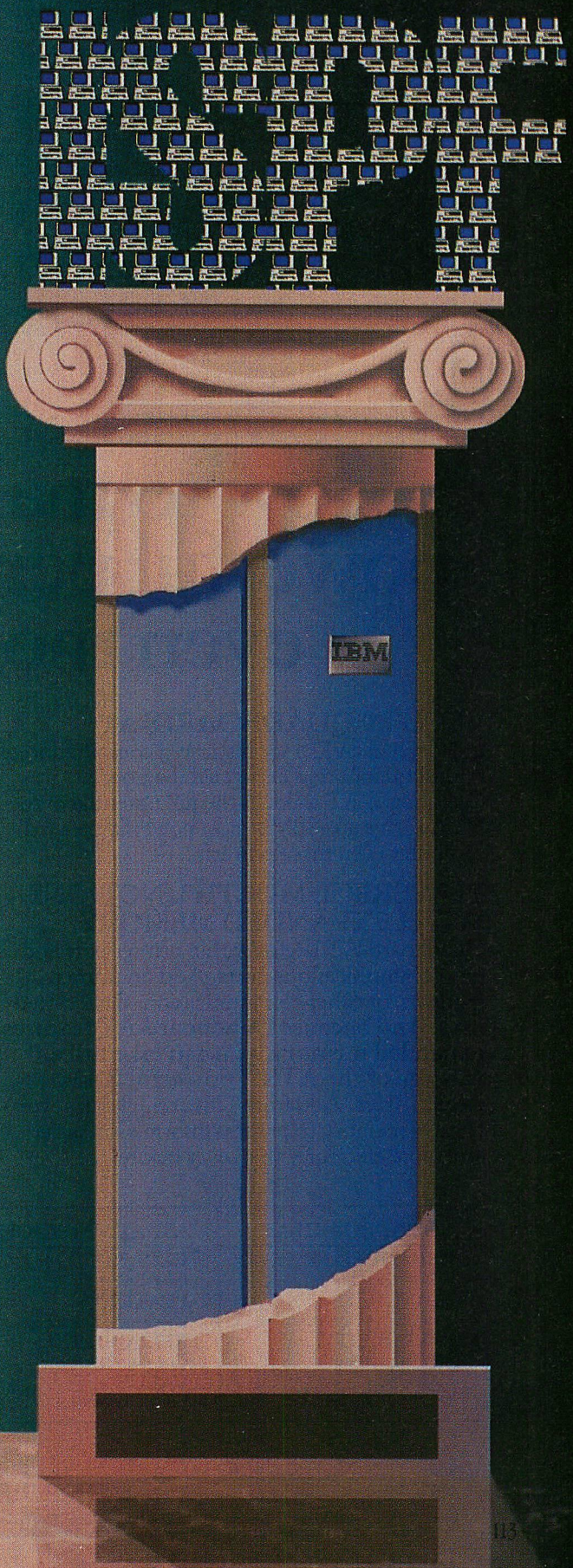
In the ISPF Tradition

Three of these four PC-based SPF editors offer a more or less full-function implementation of the IBM mainframe's powerful ISPF capabilities.

RUDY S. SPRAYCAR

Software products for editing in the IBM mainframe and microcomputer environments can be divided into three categories: line editors, full-screen text editors, and full-fledged word-processing packages. Line editors are intended primarily for the writing and editing of programs. Such editors for the IBM mainframe include IBM's TSO Edit and ADR's ROSCOE. For the IBM PC, DOS EDLIN is the archetypal line editor. Typically these products edit line by line. They are cumbersome for preparing text for documentation and they are sometimes difficult to use to produce the line indentations required in structured coding.

Full-function word processors, on the other hand, are designed to write text in paragraphs, to cut and paste, and often even to produce automatic pagination, indexing, tables of contents, and other functions desirable in preparing documentation, articles, and correspondence. Whereas line editors are



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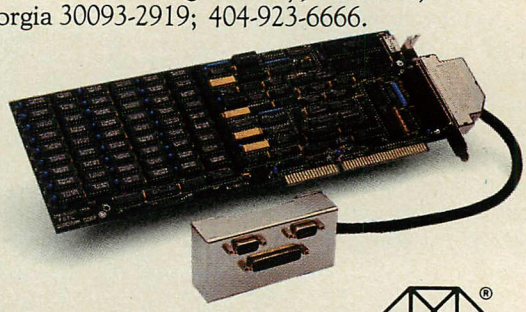
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intended primarily for a technical environment, word processors are best suited for the business setting.

The third category, text (program) editors, falls between the other two. While these products offer text processing functions and lend themselves to word processing more so than line editors, they are best suited to the production of structured program code. These three categories are not hard and fast, and some products straddle the boundaries, as was illustrated in a previous review, "18 Program Editors," (Susan Glinert-Cole, *PC Tech Journal*, September/October 1983, p. 110).

The four products reviewed in this article are program editors modeled on the ISPF mainframe full-screen editor, which is part of IBM's Interactive System Productivity Facility/Program Development Facility (ISPF/PDF). Therefore, these four implementations of ISPF are, appropriately, compared to the actual mainframe product in each area.

For programmers accustomed to the power of the ISPF full-screen editor, or to any other mainframe full-screen editor, using a line editor to write programs for personal computers is frustrating. Most users would welcome the power and convenience of an ISPF emulation for the PC. The potential for enhancement of productivity in developing stand-alone programs for personal computers is great. Word-processing programs provide full-screen capabilities in editing programs, but their functions are not necessarily tailored to the needs of program development.

Another consideration is the programmer workstation. Although this development, long prophesied, has been slow in coming, program editors of this type would be valuable where stand-alone or distributed program development is desired. Mainframe TSO files can be downloaded to the PC, or uploaded, with considerable ease, thanks to the development of reliable emulation products. (See "Emulating the 3278," Roger Addelson, *PC Tech Journal*, February 1986, p.66). Communications software can transfer files produced by the four products reviewed here between PC and mainframe TSO environments. The necessary conversion between ASCII and EBCDIC can be automatic during such transfers.

To carry this development one step further in the direction of distributed development, off-line compiles on a minicomputer or on the PC itself would be desirable as well. Although an account of them lies outside the scope of this review, products now on the market allow for development, compilation, and even test execution of programs in COBOL, permitting an upload to the mainframe of clean, executable programs. Some products promise that even command level CICS can be developed on the micro-computer (see "Personal CICS," Brandy C. De Shazo, *PC Tech Journal*, December 1985, p. 171).

PC-based ISPF-type editors thus have two markets: the mainframe/distributed workstation arena and the stand-alone micro environment. The following section offers an explanation of conventional mainframe ISPF edit functions, a summary of the basis for review and comparison.

TABLE 1: *Function and Control Key Defaults*

	APS/SPF	HCS ED.	MIC./SPF	SPF/PC	ISPF
F1	Help	Rfrsh/Hom	Help	Help	(PF1)HELP
F2	End	Split	Split	Split	(PF2)SPLIT
F3	Find	End/Save	End	End	(PF3)END
F4	Change	PrtSc	Return	Swap	(PF4)RETRN
F5	Return	Rfind	Rfind	Find	(PF5)RFIND
F6	Swap	Rchng	Rchng	Change	(PF6)RCHG
F7	Up	Up	Left	Up	(PF7)UP
F8	Down	Down	Right	Down	(PF8)DOWN
F9	Left	Swap	Swap	Left	(PF9)SWAP
F10	Right	Left	DOS	Right	(PF10)LEFT
Shift-F1	Help	Right	Undef.	Help	(PF11)RGHT
Shift-F2	End	Home	Undef.	Split	(PF12)CSR
Ins	Ins	Ins	Ins	Ins	INS
Del	Del	Del	Del	Del	DEL
Left arrow	Left cur.	Left cur.	Left cur.	Left cur.	LEFT CURS
Right arrow	Rt. cur.	Rt. cur.	Rt. cur.	Rt. cur.	RT CURSOR
Up arrow	Up cur.	Up cur.	Up cur.	Up cur.	UP CURSOR
Down arrow	Down cur.	Down cur.	Down cur.	Down cur.	DN CURS
PgUp	PgUp	Undef.	PgUp	PgUp	N/a
PgDn	PgDn	Undef.	PgDn	PgDn	N/a
Home	Home/Scrl	Undef.	Home	Home	HOME
Shift-PrtSc	PrtSc	PrtSc	PrtSc	PrtSc	N/a
Ctrl-M	Downline	Enter	Undef.	Enter	N/a
Ctrl-PrtSc	Undef.	Undef.	Undef.	PrtSc	N/a
Enter	N/a	N/a	Downline	Downline	Downline
Highlight line no.	No	No	Yes	No	Yes
Plus (+)	Downline	+	Enter	Enter	N/a
Plus (+) custom.	Yes	No	No	Yes	N/a
Tab into line number field	No	Yes	Yes	Yes	Yes

The differences in key mappings of various functions among the four products reviewed is puzzling, given the clean standard available in mainframe ISPF.

FORMIDABLE ISPF

IBM mainframe ISPF is more than simply a text editor. It is a wholly menu-driven program development facility. It includes features that provide follow-up support for programs edited in ISPF, such as on-line compiles and execution of programs, submission of batch jobs, inspection of batch job queues, routing and browsing program output and listings, ISPF edit macros, executable command lists (CLISTS) to perform various foreground TSO command functions, and Dialog Manager functions permitting design and execution of user-written screens. Mainframe ISPF also allows for customized main menus (generally by systems programmers) to provide access to locally written functions. This section will focus on the edit functions of the product.

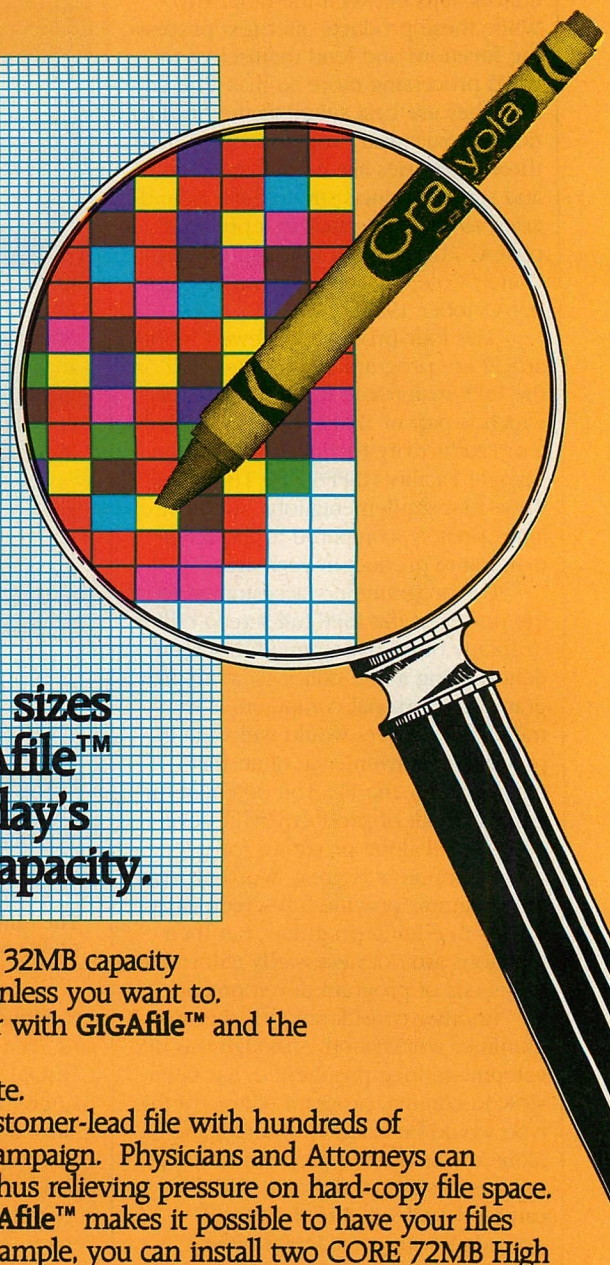
In addition to IBM's usual thorough documentation, ISPF includes a built-in segmented tutorial, which can be taken sequentially as a training package, or selectively via menu.

Function keys and scrolling. Mainframe 3270 terminals provide programmable function (PF) keys, like PC function (F) keys, to facilitate command execution with a single keystroke. The assignment of functions to the PF keys is menu modifiable. Table 1 lists PC function and control keys and the equivalent

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mainframe ISPF keys, with the default key mappings between the two for the four PC-based SPF editors reviewed.

Mainframe ISPF HELP is context-sensitive, and invokes the portion of the tutorial relevant to the functions being used. However, a submenu usually is offered permitting the user to choose related tutorial sections as well.

Two ISPF functions can be employed at once using the SPLIT SCREEN function. In the middle of an edit session, this function key can split the screen at the line occupied by the cursor, so that another file can be edited or one of the other ISPF functions invoked without terminating the first edit session or current ISPF function. Only one of these two sessions can be active at any time, however. The position of the cursor determines which of the two split-screen sessions will be active next. The user can move the cursor between the two sessions. If most of the screen is occupied by one session, invoking Swap will cause the session occupying less of the display to occupy the larger segment; the cursor will move to the other session, making it the active session while the first becomes inactive, but not terminated.

Both horizontal and vertical scrolling are available via function key.

TABLE 2: *Scrolling Commands*

	APS/SPF	HCS ED.	MIC./SPF	SPF/PC	ISPF
INTEGER	Yes	Yes	Yes	Yes	Yes
PAGE	Yes	Yes	Yes	Yes	Yes
HALF	Yes	Yes	Yes	Yes	Yes
MAX[a]	Yes	Yes	Yes	Yes	Yes
CURSOR	Yes	Yes	Yes	Yes	Yes
TOP	No	Yes	No	No	No
BOT	No	Yes	No	No	No

[a]*In command line.*

HCS Editor's TOP and BOT commands are enhancements to the ISPF standards that move the cursor to the beginning or end, respectively, of data.

Parameters that will determine the extent of the scroll are entered at the top of the screen in a field reserved for this purpose (see table 2 for a list of available commands). Supported parameters include scrolling a full page of data or half a page, as well as scrolling the line currently occupied by the cursor to the top or bottom of the screen. An integer value results in the screen's scrolling by that number of lines or columns. The TOP and BOTtom commands are not supported by mainframe ISPF, but entering MAX causes the screen to scroll to the limits of the data in any of the four directions.

The RETURN function takes the screen to the main ISPF menu, unless HELP has been invoked from another function, in which case the screen returns to the function from which HELP was called. From a submenu, END will take the screen to the next menu up in the menu hierarchy. From an edit session, END will terminate the session and save the data, and from the main menu, END will terminate the ISPF session. If the screen is split, END will terminate the active session and return control to the inactive session.

When the FIND or CHANGE commands (described below in detail) are

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TABLE 3: *Edit and Browse Primary Commands*

	APS/SPF	HCS ED.	MIC./SPF	SPF/PC	ISPF
EDIT PRIMARY COMMANDS					
LOCATE	Yes	Yes[a]	Yes	Yes	Yes
LOCATE 0 = top line	No	Yes	Yes	Yes	Yes
NUMBER	No	Yes	Yes	Yes	Yes
Supplies COBOL line numbers	No	No	Yes	Yes	Yes
.COB turns NUM on COB	No	No	No	Yes	Yes
RENUM	Yes	Yes	Yes	Yes	Yes
UNNUM	No	Yes	Yes	Yes	Yes
AUTONUM	No	No	Yes	Yes	Yes
AUTOSAVE	No	Yes	No	No	No
STATS	No	No	Yes	Yes	Yes
PRINT	No	No	Yes	Yes	Yes
RECOVERY	No	No	No	No	Yes
RESET	Yes	Yes	Yes	Yes	Yes
SUBMIT	No	No	No	No	Yes
SAVE	Yes	Yes	Yes	Yes	Yes
CANCEL	Yes	Yes	Yes	Yes	Yes
FIND	Yes	Yes	Yes	Yes	Yes
Cur. at begin of string	Yes	No[b]	Yes	Yes	Yes
Highlight line number	Yes	No	Yes	Yes	Yes
CHANGE	Yes	Yes	Yes	Yes	Yes
COPY	Yes	Yes	Yes	Yes	Yes
MOVE	Yes	No	Yes	Yes	Yes
NULLS	No	No	No	No	Yes
Default, allow insert	Yes	Yes	Yes	Yes	N/a
CREATE	Yes	Yes	Yes	Yes	Yes
REPLACE	Yes	Yes	Yes	Yes	Yes
TABS	No	No	Yes	Yes	Yes
PROFILE	Yes	No	Yes	Yes	Yes
Data type	Yes	N/a	Yes	Yes	Yes
Recovery	Sim.	N/a	No	No	Yes
Number	Yes	N/a	Yes	Yes	Yes
Caps	Yes	N/a	Yes	Yes	Yes
Hex	Yes	N/a	Yes	Yes	Yes
Nulls	Sim.	N/a	No	No	Yes
Tabs	Yes	N/a	Yes	Yes	Yes

in use, the RFIND (repeat find) or RCHANGE (repeat change) function repeats the last find or change command on the target string.

Primary commands. ISPF supports two kinds of commands: primary and line. Primary commands are entered in the command field, which normally is displayed at the top of the screen, but can be customized and made to appear at the bottom. (These commands are listed in table 3.) Line commands are entered adjacent to a particular line of data, in the generated line number field in the left margin of the screen.

A particular line can be brought up by entering the LOCate primary command, followed by a line number. Sequential line numbers in the left margin support this command. These numbers are not the same as numbers that are an integral part of the data or the program—for example, COBOL program line numbers. Such program line numbers can be created by the NUMBER command, deleted by the UNNUMber command, or renumbered by the RENUMber command. The AUTONUM command causes the file to be renumbered automatically when it is saved.

Hexadecimal displays of data can be viewed by invoking the HEX command, which can be toggled on and off with parameters ON and OFF. The hexadecimal representation of the characters on the screen is displayed in two lines below each line of characters. Two formats are available: DATA displays a hexadecimal string wrapped to the second line, including trailing blanks. VERT

	APS/SPF	HCS ED.	MIC./SPF	SPF/PC	ISPF
Autosave	No	N/a	No	No	Yes
Autonum	Yes	N/a	Yes	Yes	Yes
Autolist	No	N/a	No	Sim.	Yes
Autobak	Sim.	N/a	No	No	No
Stats	Yes	N/a	Yes	Yes	Yes
Profile (lock/unlock)	No	N/a	No	No	Yes
Imacro	No	N/a	No	No	Yes
Pack	No	N/a	Yes	No	Yes
Note	No	N/a	No	No	Yes
HEX	Yes	Yes	Yes	Yes	Yes
ON	Yes	Tog.	Yes	Yes	Yes
OFF	Yes	No	Yes	Yes	Yes
VERT	Yes	Yes	Yes	Yes	Yes
DATA	No	No	Yes	No	Yes
EBCDIC	Yes	No	Yes	Yes	Yes
Based on ASCII chars.	No	N/a	Yes	Yes	N/a
Based on hex display	Yes	N/a	No	No	N/a
ASCII	Yes	No	Yes	Yes	No
ASCII modifiable	Yes	Yes	Yes	Yes	Yes
EBCDIC modifiable	Yes	N/a	No	Yes	N/a
Modifications effective immediately	Yes	Yes	No	No	No
After pressing Enter	Yes	Yes	Yes	Yes	Yes
CAPS ON/OFF	Yes	Yes	Yes	Yes	Yes
EDIT (recurs., cmd line)	No	No	No	No	Yes
CHECK for invalid ASCII	No	No	No	Yes	No
TRANSFER	No	No	No	Yes	No
AUTOBAK	Yes	No	No	No	No
BROWSE PRIMARY COMMANDS					
LOCATE	Yes	Yes[a]	Yes	Yes	Yes
FIND	Yes	Yes	Yes	Yes	Yes
COLS	No	Yes	Yes	Yes	Yes
CAPS	Yes	Yes	Yes	Yes	Yes
RESET	Yes	Yes	Yes	Yes	Yes
HEX full features	Yes	Tog.	Yes	Yes	Yes

Sim.=simulated *Tog.=toggle* [a]*LIN* [b]*End plus one.*

"Simulated" means that, while displayed on the screen, the indicated toggle is not actually implemented in the editor's software and it conveys no real information.

displays two hexadecimal numbers vertically below each respective character. The hexadecimal numbers can be altered, and when the Enter key is pressed, any changes made to the hexadecimal numbers also are made to the corresponding character.

Two aids to editing are provided: TABS and NULLS. TABS is a primary command that brings up a tab edit line for setting or changing tab positions in the document. When NULLS is ON, lines are padded with null characters, permitting easy insertion of characters within the line. When NULLS is OFF, each line is padded with trailing blanks. If insertion is necessary, something must be deleted for each insertion, for example, deleting the trailing blanks using EOF (erase to end of field).

The file being edited in storage can be saved as a disk file using the SAVE command. Ending the edit session automatically results in such an operation. The CANcel command exits an edit session without updating the original disk file. The COPY command reads another disk file and inserts it into the file currently being edited. Similarly, the MOVE command reads a file, inserts it into the current file, and deletes the MOVEd file from disk. Part or all of the current file can be used to CREATE a new file or to REPLACE an existing one.

To accommodate documents in mixed case (mainframe programs are in uppercase), the primary command CAPS is provided. CAPS can be turned ON to permit keying in lowercase with automatic conversion to uppercase when



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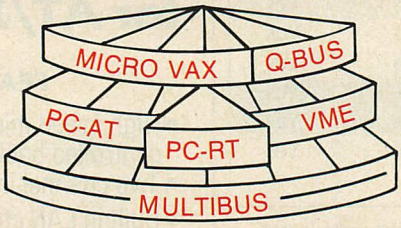
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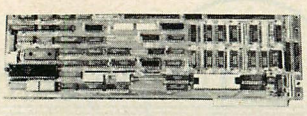
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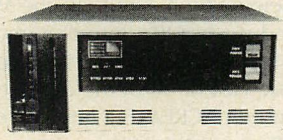
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Enter is pressed. When CAPS is turned OFF, data entry is in ASIS mode, with upper- and lowercase distinctions preserved in the data entered.

If recovery mode is on, the user is protected by *checkpointing*, which is a form of audit trail for edit changes. Change commands are saved in a temporary file that may be rerun if the edit session is somehow interrupted by a system problem: all changes that were made but not saved to the edit file before the interruption took place may be redone automatically.

The RESET command eliminates any messages, profile displays, and flags or highlights in the line number field, such as those that are created by the line commands described below.

A recent enhancement to ISPF allows the primary command EDIT to be entered recursively in the command line to start new edit sessions again and again, in addition to the two sessions available in split screen mode. Each time a new session is initiated, the prior session is suspended. The END command terminates the current session and returns to the session from which the current session was called. This process can be repeated until all of the suspended sessions have been reentered and terminated.

Find and change primary commands. The heart of the ISPF editor is its ability to find and change specified strings. The primary command FIND sets the cursor on the first character of the target string, highlights the line number containing the cursor, and displays a new screen full of data (if this is necessary to display the line containing the first occurrence of the target string). The FIND parameters are exceptionally numerous and powerful (see table 4). If a target string occurs more than once in the file, ALL positions the cursor on the first occurrence of the string and provides a count of the total number of occurrences. NEXT (the default) displays the next occurrence of the string, while PREV shows the occurrence previous to the current position of the cursor. LAST displays the last occurrence of the string in the file.

The FIND command is followed on the command line by a specification of the target string. The default condition, designated by CHARS, locates the first occurrence of a string of characters regardless of its position within a word. If the target string is bounded by spaces or a line, then the parameter WORD should be used. If the string is preceded by a space or a line boundary, then the PREFIX parameter is used; if

TABLE 4: *Find and Change Parameters*

	APS/SPF	HCS ED.	MIC./SPF	SPF/PC	ISPF
NEXT	No	No	Yes	Yes	Yes
ALL	Yes	Yes	Yes	Yes	Yes
FIRST	No	Yes	Yes	Yes	Yes
LAST	No	Yes	Yes	Yes	Yes
PREV	No	Yes	Yes	No	Yes
CHARS	No	No	Yes	Yes	Yes
PREFIX	No	No	Yes	Yes	Yes
SUFFIX	No	No	Yes	Yes	Yes
WORD	No	No	Yes	Yes	Yes
Picture Strings	Yes	No	Yes	No	Yes
P '=' any character	Yes	N/a	Yes	N/a	Yes
P '¬' nonblank	Yes[a]	N/a	Yes[b]	N/a	Yes
P '.' nondisplayable	Yes	N/a	Yes	N/a	Yes
P '#' numeric (0-9)	Yes	N/a	Yes	N/a	Yes
P '–' non-numeric	Yes	N/a	Yes	N/a	Yes
P '@' alpha. (uc./lc.)	Yes	N/a	Yes	N/a	Yes
P '<' lowercase alpha.	Yes	N/a	Yes	N/a	Yes
P '>' uppercase alpha.	Yes	N/a	Yes	N/a	Yes
P '$' special[c]	Yes	N/a	Yes	N/a	Yes
HEX	Yes	Yes	Yes	No	Yes
X/NX	Yes	No	Yes	Yes	Yes
COL1, COL2	Yes	Yes	Yes	Yes	Yes
T (FIND T 'string')	Yes	No	Yes	No	Yes
* (previous value)	Yes	Yes	Yes	Yes	Yes

[a]Caret used: P'^' *[b] Tilde used: P'~'* *[c] Not alphabetic, not numeric.*

Micro/SPF provides the most complete set of find and change features, emulating mainframe ISPF in nearly all respects; it includes the very useful FIND P'.'.

the string is followed by blanks or the end of a line, then SUFFIX is used.

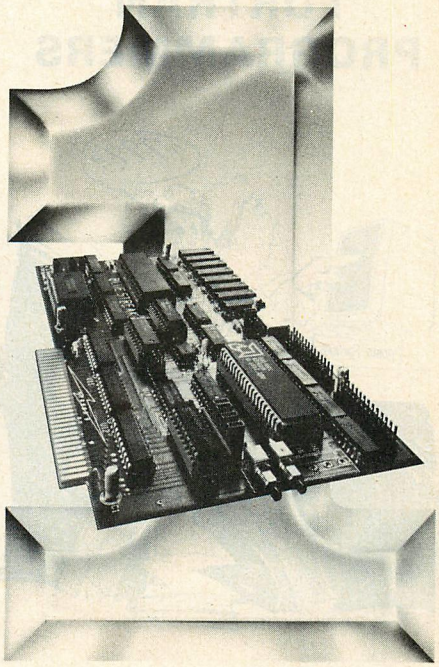
Whether or not CAPS is on, the target string will be located only if some string matches the search string exactly, including upper- and lowercase differences. If the user wishes to disregard upper/lowercase differences both in the file being edited and in the specification of the target string, the T parameter is used by entering FIND T'string'. This parameter can be combined with any of the others described above.

The target can be specified in other ways. A hexadecimal string can be specified by entering FIND X'nn', where *n* is a string of hexadecimal numbers in the file. Even more powerful is the picture specification—in the format FIND P'x'—where *x* is a character representing a data type. Table 4 includes picture string specifications, which allow locating, counting, or changing alphabetic, uppercase only, lowercase only, numeric, special, and other character occurrences. A particularly useful parameter is FIND P'.', which locates invalid (nondisplay) characters present in a file. When a file containing such characters is edited, the first display of the data comes up with a warning message to this effect, advising the user to invoke the FIND P'.' command to locate these characters.

Still other parameters can be specified. When the FIND command is followed by two integers, the search is restricted to the columns beginning and ending with these numbers. If lines have been excluded from the display by means of the exclude line command (described below), the search can be restricted to only the excluded lines using the X parameter, or to only the lines not excluded using NX.

Finally, the FIND command remembers the last string specification used: FIND * searches for the string specified for the last FIND command. The repeat find function is thus equivalent to FIND * NEXT, for finding the next occurrence of the target string.

All the special features supported for FIND can be used with the CHANGE primary command. The character, hexadecimal, and picture specifications can be used to express both the target string and the string with which the target is to be replaced. In a file containing multiple occurrences of the target, ALL changes all occurrences of the string at once; repeating the CHANGE command lets the user review all changes before they are made.



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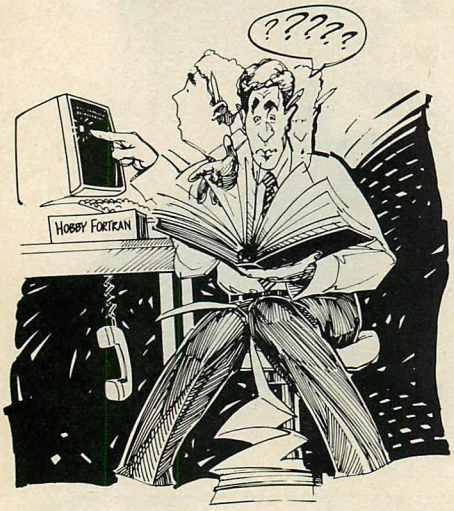
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TABLE 5: *Line Commands*

	APS/SPF	HCS ED.	MIC./SPF	SPF/PC	ISPF
COLS	Yes	No	Yes	Yes	Yes
I(nsert)	Yes	Yes	Yes	Yes	Yes
In	Yes	Yes	Yes	Yes	Yes
D(elete)	Yes	Yes	Yes	Yes	Yes
Dn	Yes	Yes	Yes	Yes	Yes
DD	Yes	Yes	Yes	Yes	Yes
R(epeat)	Yes	Yes	Yes	Yes	Yes
Rn	Yes	Yes	Yes	Yes	Yes
RR	Yes	Yes	Yes	Yes	Yes
RRn	Yes	No	Yes	Yes	Yes
M(ove)	Yes	Yes	Yes	Yes	Yes
Mn	Yes	Yes	Yes	Yes	Yes
MM	Yes	Yes	Yes	Yes	Yes
C(opy)	Yes	Yes	Yes	Yes	Yes
Cn	Yes	Yes	Yes	Yes	Yes
CC	Yes	Yes	Yes	Yes	Yes
A(fter)	Yes	Yes	Yes	Yes	Yes
An	No	No	Yes	No	Yes
B(efore)	Yes	Yes	Yes	Yes	Yes
Bn	No	No	Yes	No	Yes
MASK	No	No	Yes	Yes	Yes
<	Yes	Yes	Yes	Yes	Yes
<n	Yes	Yes	Yes	Yes	Yes
<<	Yes	Yes	Yes	Yes	Yes
<<n	Yes	Yes	Yes	Yes	Yes
>	Yes	Yes	Yes	Yes	Yes
>n	Yes	Yes	Yes	Yes	Yes
>>	Yes	Yes	Yes	Yes	Yes
>>n	Yes	Yes	Yes	Yes	Yes
(	Yes	No	Yes	Yes	Yes
(n	Yes	No	Yes	Yes	Yes
((	Yes	No	Yes	Yes	Yes
((n	Yes	No	Yes	Yes	Yes
)	Yes	No	Yes	Yes	Yes
)n	Yes	No	Yes	Yes	Yes
))	Yes	No	Yes	Yes	Yes
))n	Yes	No	Yes	Yes	Yes
BOUNDS	Yes	Yes	Yes	Yes	Yes
(e)X(clude)	Yes	Yes	Yes	Yes	Yes
Xn	Yes	Yes	Yes	Yes	Yes
XX	Yes	Yes	Yes	Yes	Yes
S(how)	Yes	No	Yes	Yes	Yes

Edit profiles. The PROFILE command produces a display that uses up to the first seven lines of the screen. The first data line begins below the profile display. ISPF allows each user to define as many as 25 different edit profiles. Each profile specifies a data type, such as DATA, COBOL, PLI, and so on. By making the lowest-level qualifier in the data set name equivalent to the name of one of these profiles, the user can cause ISPF to tailor the handling of the file automatically to the type of data that it contains. Such features as the numbering of COBOL program lines and, conversely, the suppression of explicit line numbers in documentation files can be preset in this way. (These profile parameters are listed in table 3.)

The user also can specify tab settings; whether the data are to be stored in packed (compressed) format; whether any edit macros are to be used; and whether statistics (STATS), such as the version and modification or the date last modified, are to be kept and updated on the file. Besides signaling the status of various toggled parameters, such as CAPS (ON/OFF) and NUMBER (ON/OFF), the profile display can display the current contents of the TABS, BOUNDS, and MASK lines (the

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	APS/SPF	HCS ED.	MIC./SPF	SPF/PC	ISPF
Sn	Yes	No	Yes	Yes	Yes
F(irst)	Yes	Yes	Yes	Yes	Yes
Fn	Yes	Yes	Yes	Yes	Yes
L(ast)	Yes	Yes	Yes	Yes	Yes
Ln	Yes	Yes	Yes	Yes	Yes
TABS	Yes	No	Yes	Yes	Yes
TE	Yes	Yes[a]	No	Yes	Yes
Like mainframe TE	No	No	N/a	No	N/a
TEn	No	No	No	No	Yes
TS	Yes	No	Yes	Yes	Yes
TSn = no. of lines ins.	No	No	Yes	Yes	Yes
TF	Yes	Yes[b]	No	Yes	Yes
TFn (left bnd to ncol)	Yes	Yes[b]	No	Yes	Yes
TJ	Yes	No	No	No	No
TJn	Yes	No	No	No	No
O(verlay) (receiv. lines)	Yes	Yes	Yes	Yes	Yes
On	Yes	Yes	Yes	Yes	Yes
OO	Yes	Yes	Yes	Yes	Yes
K	No	Yes	No	No	No
Kn	No	Yes	No	No	No
KK	No	Yes	No	No	No
E (exchange lines)	No	Yes	No	No	No
Perf. cmds. on excl. line	Yes	Yes	Yes	Yes	Yes
If line command entry error made (invalid cmd.), can correct with:					
Delete	No	Yes	Yes	Yes	Yes
Overtype with commandS		Yes	Yes	N/n	Yes
Overtype with number	No	No	Yes	N/n	Yes
Overtype with blank	No	Yes	Yes	N/n	Yes
Hit Enter twice	No	No	No	Yes	No
Reset	Yes	Yes	Yes	N/n	Yes
If line command entry error made (valid cmd.), can correct with:					
Delete	No	No	Yes	Yes	Yes
Overtype with commandNo		Yes	Yes	No	Yes
Overtype with number	No	No	Yes	No	Yes
Overtype with blank	Yes	Yes	Yes	Yes	Yes
Hit Enter twice	No	No	No	Yes	No
Reset	Yes	Yes	Yes	Yes	Yes

[a] TEX *[b] T* *N/n = Not needed* *S = Sometimes*

Micro/SPF's implementation of mainframe ISPF line commands is the cleanest and the most complete of all products reviewed, offering a most reliable emulation.

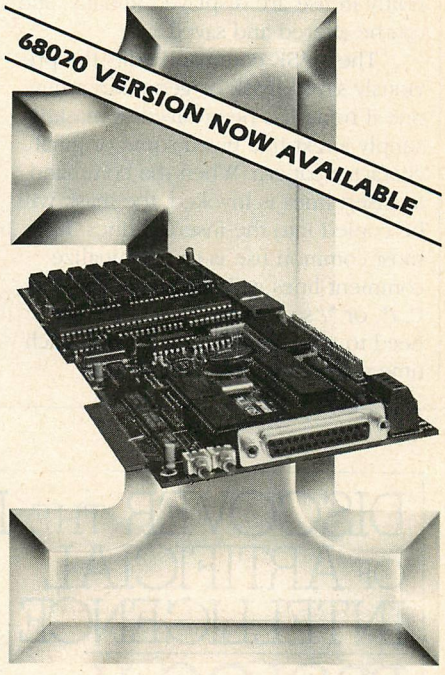
information that appears in these function lines is explained below).

Line commands. In addition to the primary commands that are entered on the command line, ISPF provides commands that are entered by positioning the cursor in the generated line number field in the left-most columns of the screen display. These commands are summarized above in table 5.

The COLS command creates a display on the line where the cursor was positioned, moving the data originally shown on that line down one line. This display provides column numbers to aid in interpreting fields in data being edited, checking column positions of structured code, and so on.

A similar display is created by BOUNDS, which shows the beginning and end of bounds for data entry, and within which text is flowed, for example, by the text flow command. Text flow in mainframe ISPF is similar to paragraph reformat in WordStar: text that has been entered "out of bounds" is automatically rearranged so that all of it falls outside the current bounds for text in that part of the edit document.

Another such line display is created by the TABS line command, for specification of tabs. The tabs that are cur-



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rently in use are displayed initially, and can be altered and saved.

The MASK command edits the previously saved mask or generates a new one if none has been saved. A mask is simply a text line given some original character pattern. When the command to insert lines is invoked, the mask will be copied into the inserted lines. Its most common use is to preinitialize comment lines with such characters as C, /*, or */ so that the user does not need to type comment delimiters each time a comment line is inserted.

Most other line commands are basically one character and have three formats: L, Ln, and LL. The command alone affects just one line; if followed by an integer, the command is applied to that number of lines. If the two-letter line command (LL, above) is typed on two separate lines, the lines between the commands become a block of lines to be processed in some way. The integer *n* can be appended to the first, last, or both occurrences of the line command. This command syntax will become clearer with examples.

The insert command, I or In, causes insertion of blank lines beginning after the line where the command is entered. The inserted lines are given null line numbers initially. After data have been entered on the inserted lines and the enter key is pressed, the new lines are numbered, existing virtual line numbers are renumbered, and any inserted new lines on which no data have been entered disappear.

The delete command, D, Dn, or DD, will delete one or more lines of data. If Dn is entered in a line number field, a total of *n* lines beginning with that line will be deleted. If DD is entered in the line number fields of two lines, the block of lines between them will be deleted.

The move (M, Mn, MM) and copy (C, Cn, CC) commands designate a line or block of lines to be moved or copied to another location within the file. Move differs from copy in that the lines are deleted from their original location after a move. This location is specified as after (A) or before (B) some other line of data, with A or B entered in the line number field of the target location. If An is specified, the block that is being moved or copied will be repeated *n* times after the target line; Bn can be used similarly.

Lines also can be "repeated." R will duplicate the specified line, and Rn will duplicate this line *n* times. Similarly, RRn entered on one line with RR entered on another line will duplicate the block of lines between them *n* times.

Parentheses, greater than, and less than symbols are quite useful as line commands in formatting structured program code. Entering) causes the entire contents of the line to be shifted one position to the right, while)n shifts all the data in the line *n* columns to the right. The block command))n and)) will shift the data in the entire block of lines *n* columns to the right. To shift data *n* columns to the left, the commands (, (n, ((, and ((n are used.

If a program contains labels or comments at the beginnings of lines that are *not* to be shifted while the body of the program is moved to the left or right, the paired commands < and <n, << and <<n, > and >n, and >> and >>n are used in the same way as the parentheses above. In any given line, these commands will shift a line left or right *excluding* any word beginning in column one. This feature allows code to be shifted to the right in pursuit of structured formatting conventions without disturbing labels that begin in column one.

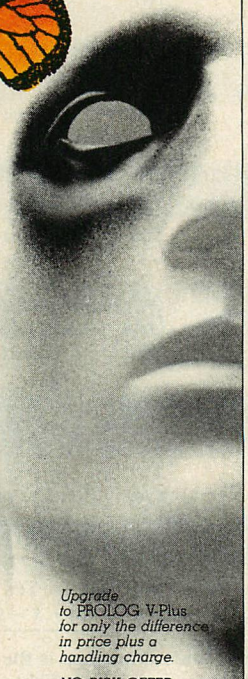
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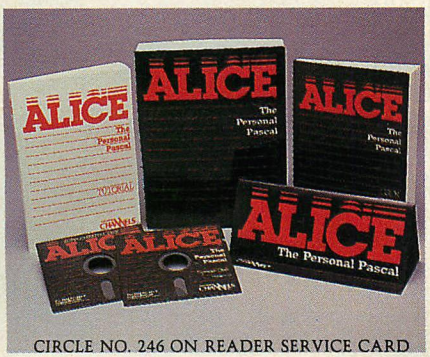
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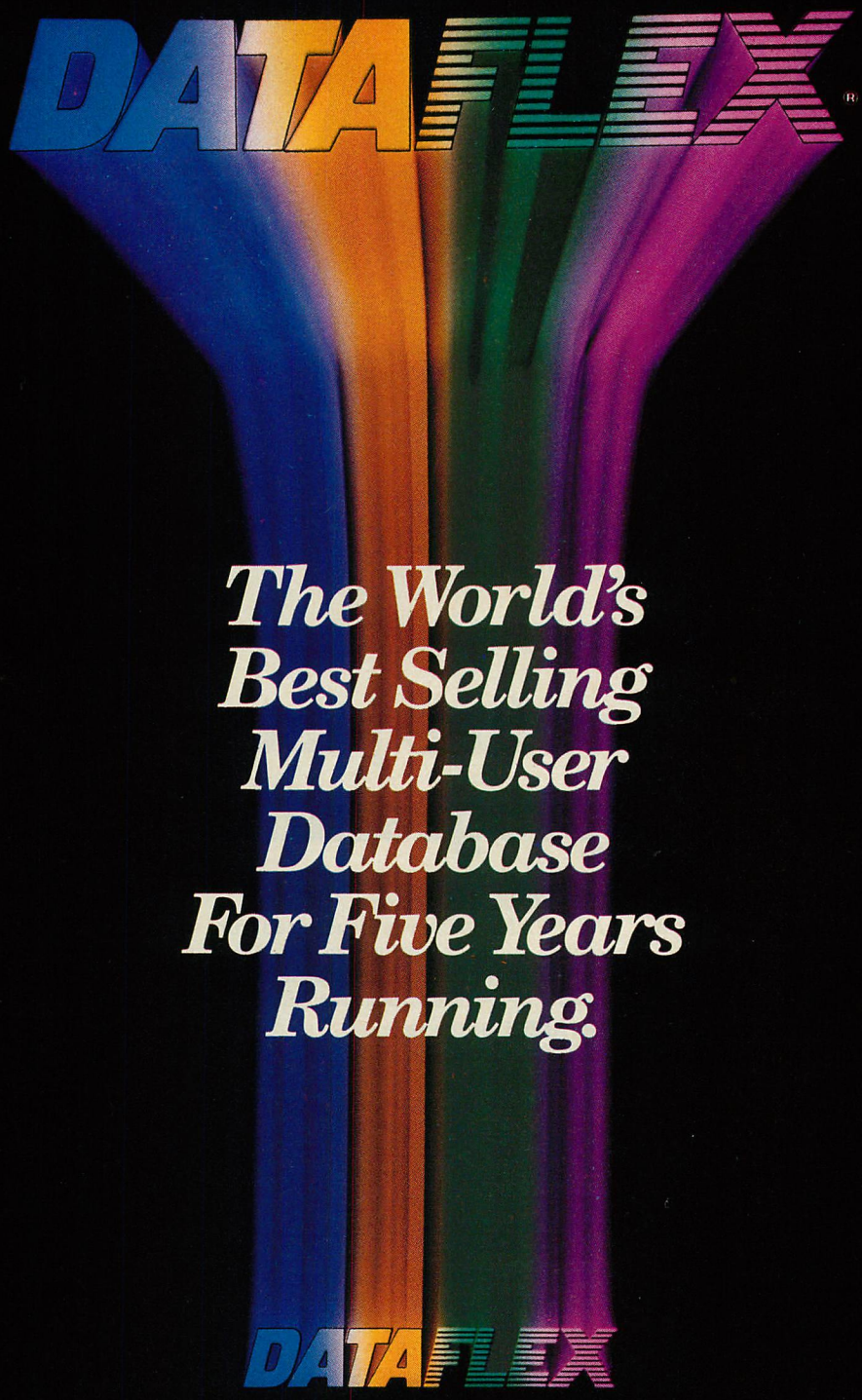
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In editing a long program, it is often desirable for the user to simultaneously view two segments that are separated from one another by many lines. Splitting the screen will not help, because two edit sessions cannot edit the same file at the same time. The solution is to exclude a number of lines from the display by entering X, Xn, XX, or XXn, as with the other commands above. The excluded lines are replaced on the screen by a single line that displays a count of the lines excluded. These lines all can be redisplayed with the RESET primary command, or brought back selectively with the show command, S or Sn, to show one or *n* lines. To show only the first few excluded lines, the user enters F or Fn in the line number field on the line representing the excluded lines; L or Ln redisplays a line or a block that begins with the last of the excluded lines.

Lines or blocks of lines can be combined using the overlay command, O, On, or OO, to designate the target lines to be overlaid, and copying (C, Cn, CC, CCn) or moving (M, Mn, MM, MMn) other lines over them. Only the blanks in the overlay target lines will be overlaid. A common use of this tool in creating documentation is to set two columns of data side by side, by first right-shifting one set of lines, then overlaying the lines already containing what is to appear in the left column.

In writing documentation, it is particularly useful to emulate word processing data entry techniques by allowing the user to disregard line boundaries and *power type*. Power type is unformatted data entry that later must be flowed into current text boundaries—the user simply types away without being concerned with carriage returns and line divisions. The TEn command will insert *n* blank lines for data entry of this type, deleting any unused blank lines when Enter is pressed. If TE is entered without an integer, blank lines will fill the screen from the line on which the command was entered through the bottom line of the screen; if Enter is pressed when the end of the last data entry line provided is reached, more blank lines are generated for further data entry. In either case, when Enter is pressed (for a second time, if more data entry lines have been generated), unused blank lines will disappear and the data will be "flowed" to fit neatly within the column boundaries that have been established using the BOUNDS command, and line numbers for the new lines will be generated. During data entry, the line number field is protected, and the user is able to enter data without concern.

The text flow (TF) command realigns data already entered to fill out lines within the BOUNDS established. This command flows the data contained on all lines beginning with the line where the command is entered and ending with the first all-blank line encountered, assumed by the product to designate the "end of the paragraph" in documentation. If TFn is entered, the right boundary established by BOUNDS will be overridden by column *n*.

If insertion in the middle of a currently existing line is required, the insert (I) command is inadequate. In this case, a variation on insert, the text split command (TS), is used. TS is entered in the line number field, the cursor is positioned on the line where insertion is to occur, and Enter is pressed. If more than one line must be inserted, TSn will insert *n* lines between the two designated segments of the line that is being split. After insertion is complete, the text can be neatly flowed back together using TF. Again,

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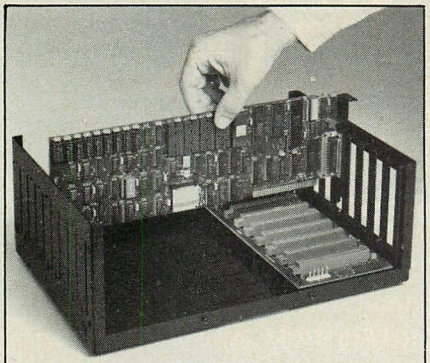


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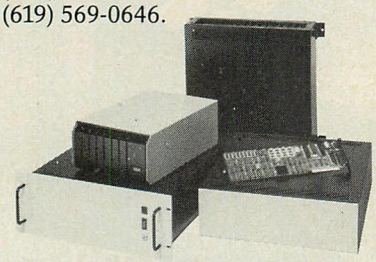
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TABLE 6: *General Features*

	APS/SPF	HCS ED.	MIC./SPF	SPF/PC	ISPF
Version reviewed	2.2	10/19/85	3.2	1.82	N/a
Language written in	Assembly	C	C	Assembly	N/a
Supports					
PC	Yes	Yes	Yes	Yes	N/a
PC/XT	Yes	Yes	Yes	Yes	N/a
PC/AT	Yes	Yes	Yes	Yes	N/a
3270-PC	Yes	Yes	Yes	Yes	N/a
DOS 2.0	Yes	Yes	Yes	Yes	N/a
DOS 3.0 and 3.1	Yes	Yes	Yes	Yes	N/a
Documentation					
Complete	Excel.	Fair	Excel.	Fair	Excel.
Correct	Fair	Fair	Fair	Fair	Fair
Well written	Fair	Fair	Excel	Fair	Fair
Use sample screens	Fair	Fair	Excel.	Fair	Excel.
Index	No	Yes	Yes	No	Yes
Table of contents	Yes	Yes	Yes	Yes	Yes
Template	No	No	Yes	No	Yes
Reference card	No	No	No	No	Yes
On-disk tutorial	Yes	No	Yes	Yes	Yes
Number of diskettes	2	1	1	1	N/a
Number of files	23	7	2	5	N/a
Copy protected	No	No	No	No	N/a
Minimum KB	256	192	320	192	N/a
Size cmd. files (bytes)	124,503	139,908	287,040	130,816	N/a
Size other files (bytes)	135,399	33,751	0+cat (var)	966	N/a
Minimum line length	40	0	0	1	N/a
Max. line length (bytes)	248	254	255	954	255(F)/ 254(V)
Max. line length, Browse (bytes)	256	254	255	954	32,767
Maximum file size	Pgs[a]	Memory	Pgs[a]	Pgs[a]	N/a
Max. file size, Browse	Pgs[a]	640KB	Pgs[a]	Pgs[a]	N/a
Helps	Yes	Yes	Yes	Yes	Yes
Context sensitive	Yes	No	Yes	No	Yes
Tutorial	Yes	Yes	Yes	Yes	Yes
DOS path support					
Parameter files	Yes	Yes	N/a	Yes	N/a
Data files	Yes	Yes	Yes	Yes	N/a
Run from any directory	Yes	Yes	Yes	Yes	N/a
Data access any direct.	Yes	Yes	Yes	Yes	N/a
DOS command processor					
Off main menu option	Yes	N/a	Yes	Yes	Yes
Off cmd. line (DOS)	Yes	Yes[b]	Yes	Yes	Yes[c]
Browse available	Yes	Yes	Yes	Yes	Yes
Full featured	Yes	Yes	Yes	Yes	Yes

this function is useful chiefly for writing documentation on this editor.

In case of errors in entering line commands in the line number field, a correct command can be entered and executed, or the erroneous line commands can be deleted or typed over with a blank or any line number. ISPF will redisplay the original line numbers when Enter is pressed. Some of the products reviewed had trouble with this correction capability, as will be discussed further on.

Browse. A subset of edit features is provided to enable the user to BROWSE a file. No changes can be made to a file that is being BROWSEd, making most edit commands unnecessary. Browse is a main menu option separate from the edit option. Its available features include LOCATE, FIND, COLS, CAPS, RESET, and all the features of the HEX command except data modification.

File organization. TSO/ISPF supports partitioned data sets (PDSs). Each PDS is a file that is itself partitioned into files

	APS/SPF	HCS ED.	MIC./SPF	SPF/PC	ISPF
Split screen	(SWAP)	Yes	Yes	(SWAP)	Yes
Utilities					
Library	Yes	No	Yes	Yes	Yes
Dataset	Yes	No	Yes	Yes	Yes
Move/copy	Yes	No	No	Yes	Yes
Cmd. line on edit screen	Yes	No	Yes	No	Yes
Foreground processing	No	No	Yes	No	Yes
Background processing	Optional	No	No	No	Yes
FIND count	Yes	Yes	Yes	Yes	Yes
CHANGE count	Yes	Yes	Yes	No	No
Flag changed lines	No	Yes	Yes	Yes	Yes
Encryption	No	Yes	No	No	No
Customize capability					
Functions	Extensive	Limited	Extensive	Extensive	No
Keys	Yes	Yes	Yes	Yes	No
Screens	No	Yes	No	No	Limited
Screen color control	No	Yes	No	Yes	No
Jump func. (=option)	Yes	Yes	Yes	Yes	Yes
Snow problem	No	No	Yes	Yes	No
Snow suppressor	No	No	Yes	Yes	No
Convenience features/displays					
Date	No	No	Yes	No	No
Time	No	No	Yes	Menu only	FUNC only
Disp. amt. free mem.	No	Yes	No	Yes	N/a
Show prog. drive/path	No	No	Yes	No	N/a
Disp. line, col. no.	No	Yes	No	Yes	No
Display file name	Yes	Yes	Yes	Yes	Yes
Display cols. displayed	Yes	No	Yes	Yes	Yes
Emulation of TSO/ISPF PDS					
TSO file names	Yes	Yes	Yes	Yes	Yes
PDS emul.–name table	No	No	Yes	No	N/a
PDS emul. as paths	Yes	Yes	No	Yes	N/a
Concat. of libraries	No	No	No	No	Yes
.EXTENSION =data set type	Yes	No	Yes	Yes	Yes
STATS display	No	No	Yes	No	Yes
TSO name list option	Yes	Yes	Yes	No	Yes
Directory selection	Yes	Yes	Yes	Util. only	Yes
Sorted list of files	Yes	Yes	Yes	Yes	Yes
DOS-style statistics	Yes	Yes	Yes	Yes	N/a
TSO-like statistics	No	No	Yes	No	N/a

[a] Pages in and out; unlimited. [b] DOS command must be preceded by $. [c] TSO command.

While HCS Editor is by far the least expensive of the products reviewed, it deviates significantly from the mainframe ISPF editor standard. None is copy protected.

that are called *members* of the PDS within the space that it occupies. As a feature of several of the ISPF menu screens, a sorted list of files within a PDS, or within a concatenation of PDSs, can be displayed by leaving the member field on the menu blank. A member of the list then can be selected for editing or browsing by entering an S in the field preceding the name of the desired file. In the same way, utility functions can provide similar sorted lists of members of PDSs, allowing for deletion, renaming, etc. of members by entering a one-letter function code in the field before the name of each member to be acted upon. In the list, various statistics are displayed for each member, including the dates when each member was created and was last modified, each member's size, and so on.

In short. The edit features of IBM's mainframe ISPF product are powerful and worthy of emulation on the microcomputer. The usefulness of such products is apparent, whether the objective is stand-alone editing of program code for execution on the PC itself, or the use of the PC as a distributed workstation to edit code that will be compiled on either the PC or the mainframe, and executed on the mainframe.

PC SPF IN ACTION

Four products were reviewed: Arrix Logic Systems' Advanced Productivity System APS/SPF (release 2.2), Command Technology Corporation's SPF/PC (release 1.82), Heuristic Computer Systems' HCS Editor (release dated 10/19/85), and) PHASER's micro/SPF (release 3.2). Their prices range from a low of $49.95 for HCS Editor to a high of $195.00 for SPF/PC, with APS/SPF priced at $145.00 and micro/SPF at $175.00. None is copy protected. Table 6 summarizes the features of these products.

Support. All of these products support the PC, PC/XT, PC/AT, and the 3270-PC, and DOS 2.0, 3.0, and 3.1. Their memory requirements range from a low of 192KB for SPF/PC and HCS Editor to a high of 320KB for micro/SPF. SPF/PC, micro/SPF, and APS/SPF theoretically are unlimited in the size of the files they can browse and edit because they support paging of edit files into and out of memory. HCS Editor supports the use of all memory not used by the program up to 640KB for files being edited. In addition, SPF/PC claims to support the Lotus/Intel/Microsoft extended memory specification, and both SPF/PC and micro/SPF support AT extended memory. Without access to AT extended memory or AboveBoard-type memory, these claims could not be verified.

All four products have full-featured browse as well as edit capability. All four support DOS paths, both for the location of the program and any parameter files required, and for the location of data files to be edited or browsed.

Compatibilities. According to the vendors, the products are compatible with TopView, various LANs, mainframe communications products, and compilers. More specifically, SPF/PC and micro/SPF offer extensive support for interaction with other products, such as multitasking available using TopView, and popular networks. micro/SPF is compatible with the Novell and 3Com networks, but has not been tested with the IBM Sytech. SPF/PC is compatible with Novell and IBM Sytech. (This information was supplied by the vendors; testing compatibilities with the extensive range of other products available lies beyond the scope of this review.)

Integrated product lines. APS/SPF is part of a series of integrated PC programmer

productivity products, including an optional product to submit and run jobs in the background, and an optional emulation of the ISPF Dialog Manager, which permits existing ISPF menu screens to be customized, as well as the creation of new ones designed to support new applications that will be developed for the IBM PC.

Functionality. All the products permit two concurrent edit or browse sessions. micro/SPF and HCS Editors support a split screen as in mainframe ISPF, while SPF/PC and APS/SPF switch between two screens, each of which occupies the entire screen while active. All support the jump (=option) function.

Utilities. Several of the utilities available under mainframe ISPF are supported by the products reviewed. Both SPF/PC and APS/SPF offer library, file, and move/copy utilities. These functions provide for file naming, renaming, deletion, and other features. The micro/SPF product includes the library and file utilities only. The exact implementation of each of these utilities varies from product to product, except for the HCS Editor, which lacks such explicit utilities. Many of IBM's ISPF utility options are useful only in the mainframe environment and are not missed on the PC.

Convenience features. A number of these are provided. All four products display the name of the file being edited, and all except HCS Editor show the numbers of the columns currently being displayed. The line and column coordinates of the current position of the cursor, a familiar word processing feature, is implemented by HCS Editor and by SPF/PC. The amount of free memory available is indicated by SPF/PC and by HCS Editor, while micro/SPF displays the name of the active disk drive. SPF/PC displays the current time on the menu only, while micro/SPF displays both date and time at all times.

Like mainframe ISPF, all four products allow that functions assigned to the function keys be customized by the user. Most allow that various other keyboard elements be customized as well. While mainframe ISPF allows the user to customize the screen only to the extent of moving the command line from the top to the bottom of the screen, HCS Editor provides substantial options to customize the screen display viewed by the user. Both SPF/PC and HCS Editor allow for user selection of the color of the screen display.

Hexadecimal displays. All four products have a HEX function that displays two ASCII digits vertically below each character. Only micro/SPF can display the ASCII in horizontal DATA format as well. All the editors except HCS Editor have an EBCDIC feature. SPF/PC and micro/SPF simply display the EBCDIC equivalents of the ASCII characters in the file. Thus, these two editors display an ASCII file's characters' hexadecimal equivalents in both ASCII and EBCDIC. However, in EBCDIC mode, APS/SPF interprets the data as if they were EBCDIC rather than ASCII. It therefore can make sense of actual EBCDIC files, which display as gibberish in APS/SPF's ASCII mode, and in both the ASCII and EBCDIC modes of SPF/PC and micro/SPF. This was discovered when a file in EBCDIC was loaded to all four products and display was attempted. Only APS/SPF and SPF/PC allow the user to modify the data when displayed as EBCDIC, and of the two, only APS/SPF performs the modifications correctly.

Speed and performance. Table 7 summarizes a variety of load, find, and change benchmarks run on two different files using the four products on both a PC/XT and a PC/AT. The PC/XT used was equipped with DOS 2.0, 640KB, a Her-

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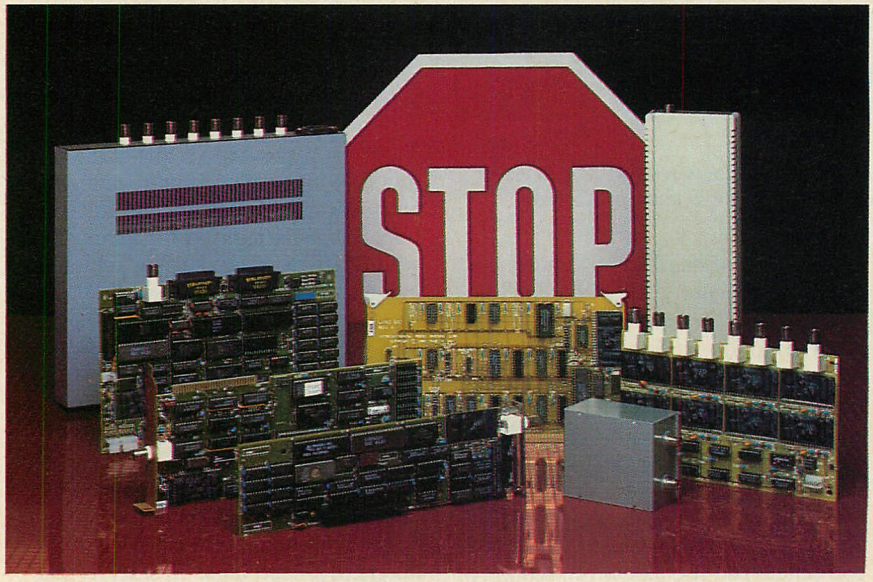
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TABLE 7: *Benchmark Performance*

	PC/AT				PC/XT			
	APS/SPF	HCS ED.	MICRO/SPF	SPF/PC	APS/SPF	HCS ED	MICRO/SPF	SPF/PC
Load editing program	2.00	2.00	3.00	1.00	9.00	5.00	9.00	5.50
Load 8,000-byte file (80 lines)	1.00	1.00	0.50	0.50	2.50	2.00	3.00	1.50
FIND string near end of file (1)	0.50	0.25	0.25	0.25	0.50	0.50	0.50	0.50
FIND ALL strings (3)	0.25	0.25	0.25	0.25	0.50	0.50	0.50	0.50
CHANGE ALL strings (3)	0.25	0.25	0.25	0.25	0.50	0.50	0.50	0.50
FIND ALL of one char. (680)	0.50	0.50	0.50	2.25	1.00	1.00	1.50	2.00
CHANGE ALL of one character (680)	0.50	0.75	1.50	2.75	1.50	1.00	3.50	2.00
FIND ALL of one string (600)	0.50[a]	0.50[a]	0.50	2.25	0.50[a]	1.00[a]	1.50	2.00
FIND ALL of one char. (6,465)	2.25	0.50[a]	4.00	24.00	5.50	1.00[a]	12.00	11.00
FIND ALL of one hex string (6,465)	2.25	0.50[a]	4.00	Can't	5.50	1.00[a]	12.00	Can't
FIND ALL using picture string (699)	1.00	Can't	1.00	Can't	2.00	Can't	2.50	Can't
FIND ALL chars using picture string (8,000)	2.50	Can't	5.00	Can't	7.00	Can't	14.00	Can't
Load 165,200-byte file (2,065 lines)	25.00	16.00	16.00	13.00	62.00	43.00	22.00	34.00
RESET	1.00	0.50	0.50	0.50	1.50	1.50	1.50	1.00
SCROLL LEFT/RIGHT	0.25	0.50	1.00	0.25	0.25	0.25	0.25	0.10
MAX up/down	0.50	0.50	1.00	0.25	1.00	1.00	0.25	0.25
FIND string near end of file (1)	1.50	8.00	8.00	5.00	3.00	22.00	8.50	2.00
FIND ALL strings (3)	1.50	8.00	10.00	5.00	3.50	22.00	8.50	2.00
CHANGE ALL strings (3)	1.50	8.00	10.00	5.00	3.50	22.00	8.50	2.00
FIND ALL of one character (14,042)	5.00	10.00	22.00	57.00	14.00	28.00	33.00	35.00
CHANGE ALL of one character (14,042)	7.00	15.00	37.00	57.00	19.00	37.00	82.00	36.00
FIND ALL of one string (12,390)	2.00[a]	9.00[a]	21.00	52.00	5.00[a]	23.00[a]	31.00	32.00
FIND ALL of one character (132,140)	37.00[a]	27.00[a]	85.00[a]	503.00[a]	104.00[a]	73.00[a]	233.00[a]	315.00[a]
FIND ALL of same string in hex (132,140)	37.00[a]	27.00[a]	85.00[a]	Can't	104.00[a]	73.00[a]	233.00[a]	Can't
FIND ALL spec. chars using P'$' (146,621)	45.00[a]	Can't	97.00[a]	Can't	126.00[a]	Can't	265.00[a]	Can't
FIND ALL chars, pic string P'=' (165,200)	45.00[a]	Can't	102.00[a]	Can't	132.00[a]	Can't	287.00[a]	Can't

[a] This product's count of string occurrences does not agree with that obtained by a SNOBOL string-counting program on the PC.
Note: all times are in seconds.

Different interpretations of a string occurrence lead to differences in counts by mainframe ISPF and by the SPF editors.

cules Color Card, and a Taxan RGB 425 monitor; the PC/AT was equipped with DOS 3.1, 512KB, an IBM color graphics card, and an IBM color monitor. All files were loaded from directories located on the hard disks to minimize I/O time not directly associated with the software's performance. Not all tests could be run in all cases because of some specific product limitations.

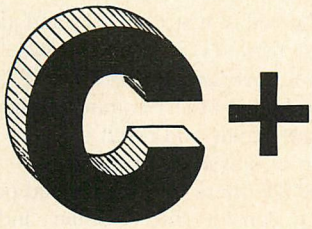
Generalizations can be made from these results. Particularly on the AT, the performance of all products was generally acceptable in handling the smaller file. When the large file was edited, APS/SPF and SPF/PC were unusually fast in handling "normal" requests involving single or multiple find or change requests for target strings that occur infrequently in the document.

The determination of which product performed better depended upon the hardware. Although the AT is ordinarily faster than the XT, the AT used had less memory than the XT. SPF/PC's optimizations seem to become millstones when it is asked to crunch large numbers of searches for strings recurring so often as to constitute the bulk of the document. Under similar circumstances, micro/SPF also performed slowly. APS/SPF is generally ahead on this score, although table 7 should be examined with care if speed is an important consideration.

Incidentally, the counts of strings found provided by the software occasionally varied from those that would be found using mainframe TSO/ISPF. Consider, for example, the task of counting the number of times a substring such as '*****' might be found in a string such as

'**********'

Mainframe ISPF, micro/SPF, and SPF/PC would all find this substring 30 times in this string—the first beginning at posi-



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abs	conbuf	feof	getcseg	isascii	movmem	replace	strcat
asm	conc	ferror	getdseg	iscntrl	open	repmem	strcmp
asmx	cos	fflush	getd	isdigit	outp	rewind	strcpy
atan	cpystr	fgets	putd	islower	peek	right$	strlen
atof	creat	fileno	getdate	isprint	perror	rindex	strncat
atoi	cursblk	filetrap	gettime	ispunct	poke	rmdir	strncmp
atol	curslin	find	geti	isspace	poscurs	scanf	strncpy
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bdosx	cursrow	fopen	getkey	itoa	printf	setbufsiz	system
bios	cursoff	fprintf	getmode	keypress	putc	setcolor	tolower
biosx	curson	fputs	setmode	left$	putchar	setdate	toupper
calloc	delete	fread	gets	len	puts	settime	ungetc
ceil	drand	free	getw	log	putw	setjmp	ungetch
cfree	exec	freopen	heapsiz	log10	rand	setmem	unlink
chain	execl	fscanf	heaptrap	longjmp	read	sin	write
character	execv	fseek	hypot	lseek	readattr	sound	writechs
chdir	exit	ftell	index	malloc	reach	sprintf	xmembeg
chmod	exitmsg	fwrite	inp	alloc	writech	sqrt	xmemend
clearerr	exp	getc	insert	mathtrap	readdot	srand	xmemget
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cmpstr	fdopen	getchar	isalpha	modf	rename	str$	_exit

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tion 1, the second at position 2, and so on. APS/SPF and HCS Editor, on the other hand, start looking for the next occurrence of the substring on the character beyond the end of the last occurrence; that is, it locates the substring at position 1, position 6, position 11, and so on. This accounts for one kind of variation in substring counts.

In the case of the very large numbers of string occurrences in the big file, tab characters can account for differences in counting padded blanks. Even when all blanks have been replaced with some other character, some of the counts differ from counts obtained on the personal computer, using a string-counting program written in SNOBOL for this purpose. The products' reliability in counting very large numbers of strings is an unresolved issue that would be a detriment only in unusual situations.

STRONG AND WEAK

APS/SPF. APS/SPF's strongest point is that it is a part of an integrated series of products for a distributed programmer workstation. Rather than depending upon compatibility with other products on the market, ALSI provides as extra-cost options features beyond the edit capability reviewed here, including a job submission utility and a microcomputer version of ISPF Dialog Manager, allowing the programmer to design and implement menus and screens.

In addition, this product was one of the two speediest in the benchmarks; on the AT it was consistently the fastest, except in some highly repetitive tasks.

The documentation is unusually complete and thorough, but may be hard to reference due to its lack of an index. The system can be extensively customized and tuned by the user. Considerable control over the location of the virtual memory for swapping is possible, so that a RAM disk could be exploited to improve performance.

On the other hand, only swap-screen, rather than full split-screen capability, is available under ASP/SPF. Another limitation is that the minimum line length is 40 characters, in contrast with zero or one-character minimum line length with the other products. This might not concern individuals using only 80-character card images. Lines entered with fewer than 40 characters are padded out to 40 with blanks. APS/SPF's profile command displays three toggles present in mainframe ISPF (RECOVERY, NULLS, and AUTOBAK) that are *not* implemented in this software and *cannot* be turned on and off. These nonexistent toggles are displayed simply to make the screens resemble those of mainframe ISPF.

Many of the FIND and CHANGE parameters of mainframe ISPF are absent, including FIRST, LAST, PREV, PREFIX, SUFFIX, and WORD.

APS/SPF exhibits differences in the default implementations of several functions: the Home key does not work on the file selection screens, and on the edit screen, hitting it repeatedly causes alternation between the command and the scroll parameter fields, rather than repeated returns to the command field. Pressing the END function key from APS/SPF's main menu will not terminate the session, as it will in mainframe ISPF, micro/SPF, HCS Edit, and SPF/PC; the letter X must be pressed instead. These changes could be regarded as improvements or as distractions to those familiar with mainframe standards.

The default Tab key function will not take the cursor off the command line. Once the cursor is on a data line, the tab key will not take the cursor into the line number field as with mainframe ISPF and the other products; cursor directional keys must be used to enter the line number field. If COLS has been set to display column numbers and then the user changes to HEX mode, the COLS line is lost and the command must be reentered to recover the column number display. Also, in the TF*n* command, *n* represents the number of columns across that the text is to be flowed, rather than the number of the right column boundary for the flow. This is a subtle departure from established ISPF practice. Again, these departures from mainframe usage are specific only to APS/SPF.

APS/SPF is fast and flexible, and is part of an integrated series of products for a programmer workstation.

A drawback to the use of virtual memory in APS/SPF is that when a work data set is being used, the exclude (X) line command is not operational. A bug is present in the overlay block command (OO); if a line is overlaid with a blank line, the software returns a single O in the number field of the line being overlaid, with a message signaling (incorrectly) that an overlay is still pending. If the use of text flow (TF) and justified text flow (TJ) is combined with an error in the use of a line command followed by the RESET command, the results are erratic and result in the insertion of unwanted blank lines.

APS/SPF offers very high speed performance, considerable flexibility, and integration as part of a complete programmer workstation package. It has a number of reliability quirks, however, and lacks certain ISPF features.

HCS Editor. Unlike the other three products, which can be characterized as more or less full-function ISPF, HCS Editor lacks a main menu, separate utilities functions, and separate screens for edit and browse. The function that allows the user to customize the system is not a main menu option as with the other products and mainframe ISPF, but instead is a program that is executed separately from DOS. These differences from ISPF, it could be argued, might account for its needing less memory than two of the other products. Since this product cannot exploit virtual memory techniques, it must try to keep main memory as free as possible to accommodate the edit file. These sacrifices in format and function may be of little consequence to the user who has not already grown accustomed to mainframe ISPF, but to the ISPF old-timer they can be jolting.

HCS Editor has simpler implementations of the display of free memory and customized color control than does SPF/PC. Its other simplifications of mainframe ISPF include toggles without explicit ON/OFF operands for the COLS and HEX commands.

Some of the most sophisticated features of ISPF are absent, such as the FIND Picture string argument, and the PREFIX, SUFFIX, and WORD parameters of the FIND function.

All line edit commands are implemented as single-letter commands. For example, T is used instead of TF for text flow. HCS Editor's tendency to scan for only the first letter entered as a line command therefore results in a Copy command, if COLS is mistakenly entered in the line command rather than in the primary command field.

If T stands for text flow, then text edit cannot be TE, but TEX instead. When TEX text entry mode is in operation, the scroll left and right functions are unavailable, although this is no serious handicap. A more serious problem is that the text flow command will sometimes flow the text out to the maximum line length of 254, even though the data entered were in an 80-column

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COBOL file, so T*n* must be used to control this function.

Several times, this product hung up and could be exited only by warm boot. On one occasion, when the product was brought back up after such a boot, the edit menu was filled with data from the file that had been under edit. The screen would accept no new commands, successive rebooting could not clear up the problem, and resolving it required reinstallation to the hard disk from the distribution diskette.

One particular advantage of HCS Editor is its ability to encrypt data. This feature is unique among the four products reviewed, and it is not a function offered by mainframe ISPF.

While HCS Editor is in some ways a stripped-down product, and still contains a number of irritating bugs, it could be worth its low price of $49.95 to those who do not insist upon complete mainframe ISPF compatibility or IBM-class reliability.

micro/SPF. This product's strong suit is reliability. Many software developers' ideal is to make software bulletproof. Certainly it requires considerable effort to break or hang mainframe ISPF through the keyboard. While all four of these products are moderately reliable when directions are followed, micro/SPF probably would hold up best to a monkey tapping on the keyboard.

PHASER also deserves credit for its professional documentation. Its manual is thorough, easy to read, and attractively formatted. A rugged keyboard template for the function keys is provided.

PHASER indicates that micro/SPF has been tested and found to be compatible with the following compilers: Micro Focus COBOL, REALIA COBOL, DRI PL/1, and DRI FORTRAN. Editor compatibility in this sense means that no control characters or "high-bit" information is added to an edit file, and that program source code edited with the editors will be cleanly compilable by the compatible compilers. These compatibility claims have not been independently confirmed by *PC Tech Journal*.

For those desiring mainframe communications in connection with ISPF edit work on the PC, two options are offered. Included in the price of micro/SPF is the Network Communications Facility (NCF). The required mainframe portion of NCF is available on magnetic tape upon request for no additional charge. PHASER'S Virtual Disk Access Method (VDAM) mainframe communications package, allowing TSO/ISPF emulation on the PC not only in its local environment but on the mainframe as well (as a substitute for TSO) is considerably more expensive at $4,950 for a five-node installation. Neither of these products was tested.

This is the only one of the four products that does not imitate ISPF's support of Partitioned Data Sets (PDSs) simply by prompting for DOS paths in place of PDS names on the edit menu. Instead, micro/SPF attempts to emulate the PDS concept fully by means of a catalog function that maintains a table of equivalences between PDSs and simple system-named files (of the form SPF34201.PSI). The statistics offered in the sorted lists of PDS members are more like mainframe TSO/ISPF, as well, in providing the length of the file in number of lines rather than in the number of bytes, as is the case with DOS. Both file size measures are thus available to the micro/SPF user.

The additional overhead to maintain and consult the catalog table seems inconsequential, and this approach is fine if the user will be accessing his files only through micro/SPF, but it makes DOS file names extremely cryptic. To be sure, existing, conventionally named files can be added to the micro/SPF catalog, but some may find this feature cumbersome in use.

Because micro/SPF does not initialize an edit profile for a given file based on its DOS extension (.COB, .BAS, .PAS, etc.), NUMBER ON COBOL (NUM ON COB) had to be entered at the beginning of each session involving a COBOL file. The BOUNDS parameter sometimes was initialized without a valid right bound. As a result, the command FIND ' ' ALL on a small file produced displayable data (although garbage) to the left of what should have been the left bound of the data (column 1), and even the redoubtable RESET command was unable to correct the problem. This was the only reliability problem encountered with the micro/SPF product.

As the tables show, a few ISPF features, including text entry (TE) and text flow (TF), are absent from this product. Nevertheless, the features present are in general so cleanly implemented that for users requiring high reliability, this product is well worth the $175 price.

SPF/PC. This is a sound product that offered the fastest performance on the PC/XT when doing such normal tasks as repeatedly finding or changing a string occurring only a few times in a file. Its performance bogged down only on string-crunching benchmark activities that ordinarily would be performed by custom string processing programs any-

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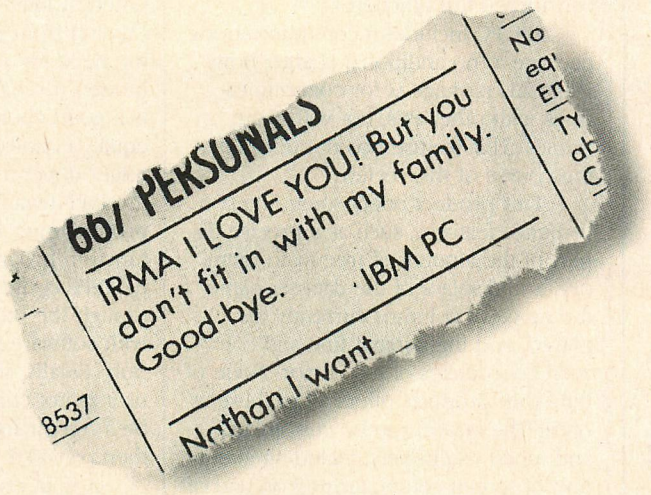
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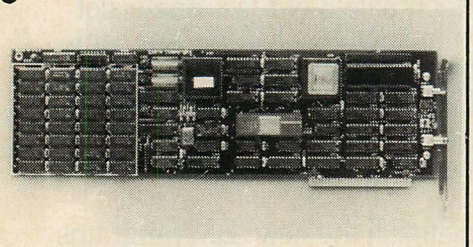
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way. As a further confirmation of its efficiency, SPF/PC's memory requirements are the lowest of the three full-function products reviewed. (HCS Editor is not close enough to mainframe ISPF to be considered full function.)

SPF/PC includes a communications package at no additional charge; however, this package is for communications with other PCs, not with mainframes. This feature was not tested in the course of this review.

This product offers some fine convenience features, such as a precise display of the amount of free main memory, and displays of the data set name, the range of columns currently displayed, and the current line and column coordinates of the cursor. None of the other products offers all of these at once. The system can be customized and tuned extensively, including alteration of screen colors, turning on and off expansion and compression of data blanks using tabs, and so on.

On the down side, the profile command displays one nonexistent toggle: the mainframe AUTOLIST function. As with APS/SPF, this is an attempt to mimic mainframe ISPF editor screens, but displaying toggles that are not supported by the product is misleading. Also, the CAPS ON function is not implemented as it is on mainframe ISPF, by converting lowercase input to uppercase when Enter is pressed; rather, CAPS ON works like CapsLock. The text flow (TF) command shows evidence of some subtle bugs; on one occasion, when strings of characters were trimmed off the ends of several lines in between two uses of the TF command, the product hung up, and eventually required a warm boot to recover.

More seriously, an attempt to alter data on the HEX display can cause the SPF/PC to hang up, making it necessary to warm or even cold boot the computer to get out of trouble. This is particularly the case with the HEX EBCDIC display. HEX EBCDIC should be used with caution, if at all.

While most of the mainframe ISPF features are available in this product, it is important to note that the extraordinarily powerful Find Picture function is not present; neither is the HEX DATA display option.

To be sure, this package, like the other products, is missing a few of the features implemented on mainframe ISPF, and it also exhibits occasional lapses in reliability. But its overall reliability and benchmark performance in routine word processing tasks do justify its high-end price of $195.

SUBTLETIES

The accompanying tables compare the subtle differences among these products; no one editor will be best for everyone. First, functionality: because different mainframe ISPF features are missing from each product, knowing the need for particular features is paramount. If reliability is crucial, micro/SPF is a good choice with SPF/PC nearly equal; a choice between these two might depend upon the differences in the ISPF features that each offers. If the product must be integrated with a full-function programmer's workstation, APS/SPF could be the best choice, although the others may be compatible with software that provides similar support. Finally, if price is critical and the user is not concerned that the product be a mirror image of mainframe ISPF, then consider HCS Editor at $49.95.

A final note: Each product went through several releases while this review was in preparation, and further releases are to be expected before the article is printed. Many of the shortcomings noted have been brought to the vendors' attention; any or all could be addressed in future releases.

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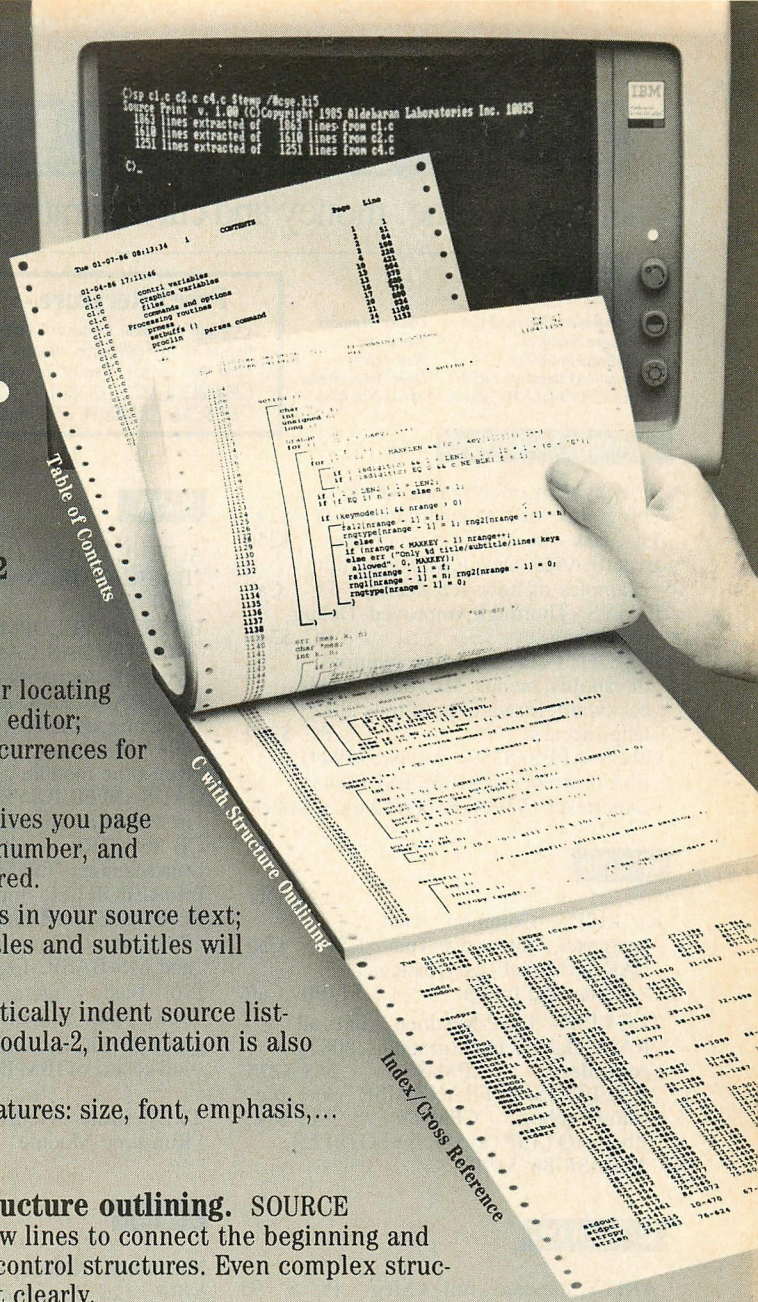
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```
46  ┌─procedure shellsort;  (* <s> Shell Sort *)
47  │    label 1;
48  │    var ind1, ind2, hint, vect:  integer;
49  ├─begin
50  │    hint := 1;
51  │  ┌─repeat
52  │  │    hint := 3 * hint + 1
53  │  └─until hint > STEPS;
54  │  ┌─repeat
55  │  │    hint := hint div 3;
56  │  │    for ind1 := hint + 1 to STEPS do
57  │  │  ┌─begin
58  │  │  │    vect := aray[ind1];
59  │  │  │    ind2 := ind1;
60  │  │  │    if aray[ind2-hint] > vect then
61  │  │  │  ┌─repeat
62  │  │  │  │    aray[ind2]:=aray[ind2-hint];
63  │  │  │  │    ind2 := ind2 - hint;
64  │  │  │  └─until ind2<=hint or aray[ind2-hint]<=vect;
65  │  │  │    aray
66  │  │  └─end;
67  │  └─until hint
68  └─end;
```

Routine Extraction

```
C>sp c1.c c2.c c4.c $temp/cal$ @proclin,control,proclin2,setxcol,dblold
Source Print  v. 1.10 (C)Copyright 1986 Aldebaran Laboratories Inc. 11732
   159 lines extracted of   1863 lines from c1.c
    37 lines extracted of   1610 lines from c2.c
    64 lines extracted of   1251 lines from c4.c
```

BASIC

```
 10  REM ***** <s> She
 20    H = 1
 30    H = 3 * H + 1
 40    IF H <= N THEN GOTO 30
 50    H = INT(H / 3)
 60    FOR I = H + 1 TO N
 70        V = A(I) :  J = I
 80        WHILE A(J - H) > V
 90            A(J) = A(J - H)
100            J = J - H
110            IF J <= H THEN GOTO 130
120        WEND
130        A(J) = V
140    NEXT I
150    IF H <> 1 THEN GOTO 50
```

Program structure outlining. SOURCE PRINT can draw lines to connect the beginning and end of nested control structures. Even complex structures stand out clearly.

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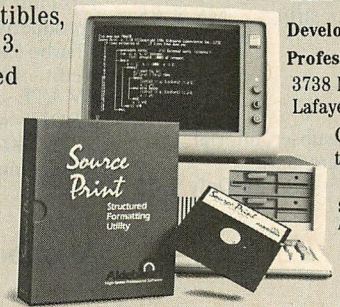
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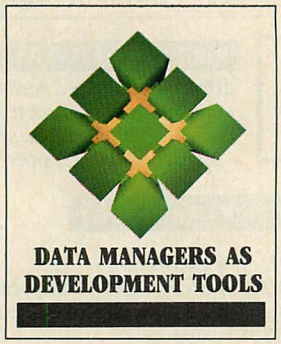
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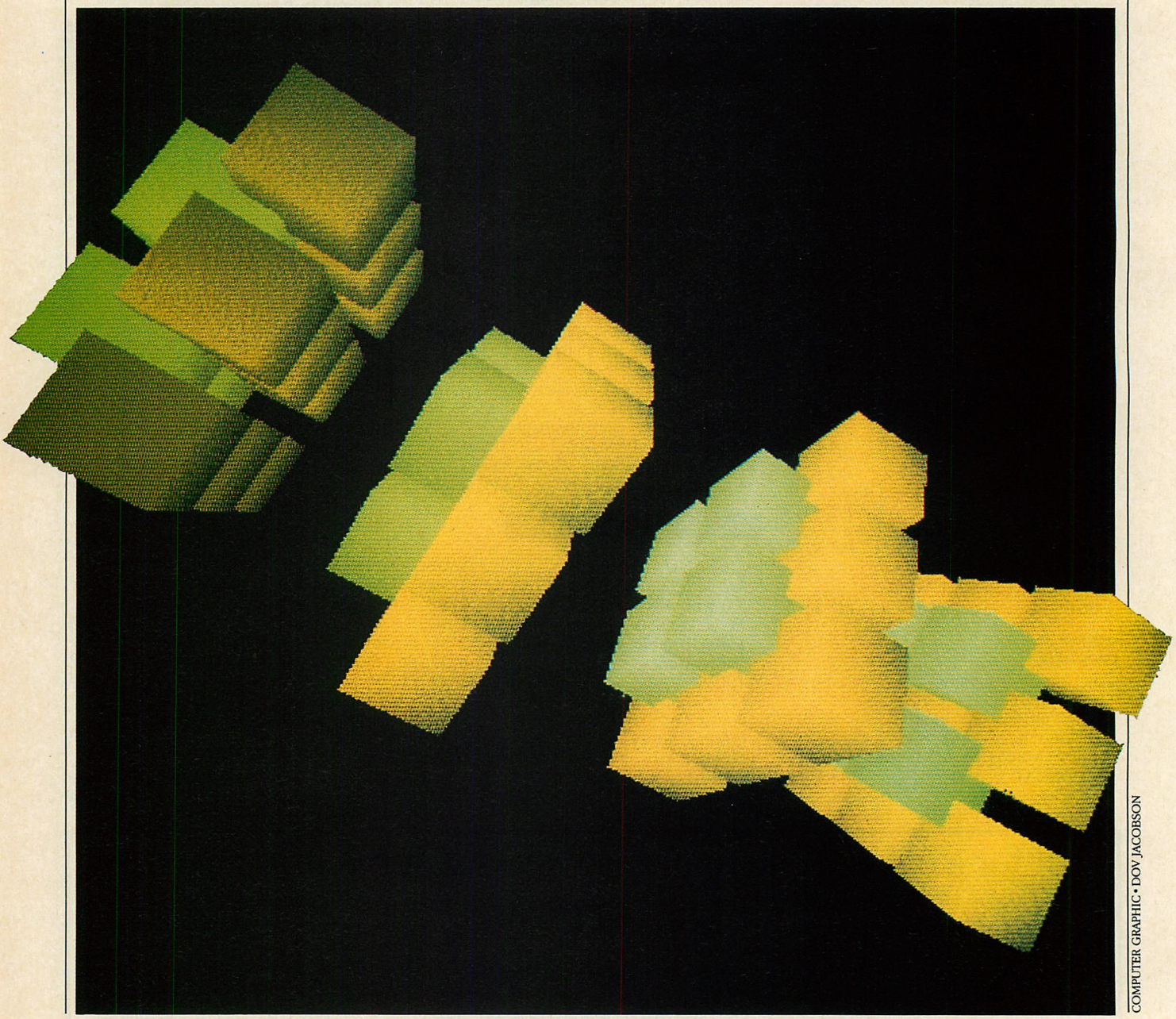
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A Data Manager for Transaction Processing



COMPUTER GRAPHIC • DOV JACOBSON

Applications developed with PROGRESS possess features—crash recovery, portability, transaction processing, and a sensible query facility—that developers would have trouble delivering otherwise.

MARK KARAMAN

Data Language Corporation was founded in 1981 by veterans of the mainframe environment with extensive backgrounds in data management and fourth generation languages. Having made significant technical contributions to products such as the MIMS fourth generation language and database by Mitrol and the Model 204 database by Computer Corporation of America, developers at Data Language set out to create an applications development system for UNIX supermicros. In August 1984 Data Language introduced the first UNIX implementation of PROGRESS, a multiuser database and fourth generation language integrated within a development environment that includes an editor, data dictionary, compiler, and security facilities.

A reflection of its origins, PROGRESS possesses many mainframe-like features, including transaction processing, automatic crash recovery, and security. Transaction processing is a concept new to many microcomputer applications developers, but its benefits cannot be overstated. When combined with automatic crash recovery, it gives developers the ability to deliver fault-tolerant applications without programming somersaults. PROGRESS contains many such intrinsic qualities that add significant value to applications without requiring additional coding.

PROGRESS has received significant acclaim in the UNIX marketplace and currently runs on dozens of multiuser systems including the DEC VAX 11/780 and AT&T 3B5. A DOS version was first released in March 1985. This single-user PROGRESS runs under DOS 2.1 or greater on an IBM PC, PC/XT, or PC/AT. PROGRESS requires at least 512KB of RAM and a hard disk to operate and with "the works" occupies at least 2MB of disk storage. Pricing for the gamut of machines to which PROGRESS has been ported ranges from $695 for the PC to $19,500 for the DEC VAX 11/780, as the accompanying sidebar shows.

PROGRESS is written in both C and assembly language. Data Language's primary reason for using C was portability. Data Language provides source-code compatibility across all systems as well as a uniform integrated applications environment. It is 100-percent compatible with Borland's SideKick.

Last year, Applied Data Research (ADR), a leading vendor of mainframe database and fourth generation language software, reached a $2 million nonexclusive license agreement to develop products using PROGRESS technology. This was a significant endorsement of the product's database and applications development environment.

This eighth in a series of data manager reviews explores PROGRESS 2.3d. Using *PC Tech Journal's* sample application as a springboard, the information and analysis that follows form a basis for direct comparison with other applications development systems in this series. (For a description of the sample application, benchmarks, and review methodology, see "Sample Application Specifications," August 1985, p. 48. The article is also available for downloading on PCTECHline, 301/576-PCTJ.)

DATABASE DESIGN

PROGRESS uses the relational data model, which results in a very flexible database environment where relationships between files can be created freely using common data fields and do not have to be specified in advance.

A single PROGRESS database can contain as many as 1,023 files and 1,023 indexes with a minimum of one index per file, but no maximum number of indexes per file. Each index can contain as many as 10 fields but cannot exceed 127 bytes in length. Character fields are variable length and can be up to 255 characters long. Record size is limited to 2,000 bytes and presents the only limit on the number of fields per record. The number of files and records that can be active at any one time is set by record buffer capacity, which can be defined from 1KB to 31KB in size.

All fields of a record are of variable length. They can be character, date, integer, decimal, or logical with arrays supported for all types. Table 1 gives the range of values for each data type as well as the amount of disk space each type uses within the record.

Some interesting implications to software developers are also revealed in table 1. With PROGRESS a developer can specify large comment fields, but the only storage space consumed is that needed to store the actual data. Unlike dBASE III memo fields, PROGRESS variable length fields can participate in all logical comparisons, substring, string search, and concatenation operations.

To find a particular record within a file, PROGRESS maintains a list of record identification (RECID) numbers paired with offset values. These RECIDs are the lowest access PROGRESS allows the developer and are most often used to pass explicit record references between procedures. PROGRESS performs indexing by maintaining lists of RECIDs paired with key values in b-trees.

TRANSACTION PROCESSING

Perhaps PROGRESS's most significant contribution is a comprehensive transaction processing implementation. All processing related to a single transaction is described within a transaction block. The

language syntax for doing this is described later. As each record in the database is modified, its previous value is written to a *before image* (.BI) file. If processing of the entire block is not completed—because it was aborted by the user, a program undo request, or a system crash—information in the .BI file is called upon to restore the database to its pretransaction state.

Power failures and user reboots have long been the bane of complex applications. Often resulting in partially updated indexes or working files out of phase with global records (highest account number, year-to-date totals, etc...), such exits leave insidious errors in an application's data files. Any abnormal termination of a PROGRESS application will result in a message at restart:

**** The last session was abnormally terminated.**
**** Your database is being repaired ....**

and, short of any massive file damage, this message appears:

**** Your database has been repaired, you may have to redo the last task.**

The data integrity feature can be overridden with a -i start-up parameter. This is recommended for initial loading of data or for massive file updates (such as year-end processing of a large multiuser application) in which the extra disk accesses from writing to the before image file might slow down the process considerably. Naturally, the entire database should be backed up before invoking PROGRESS with the -i parameter. In the XENIX version of PROGRESS a single-user start-up flag is also available. This prevents processing hang-ups caused by record lock-outs and speeds massive file updates when used in conjunction with the -i start-up option.

No extra programming is required to take advantage of the transaction processing feature. On the contrary, adjustments may be required to reduce the scope of a transaction. Default transaction blocks left unmodified on long loops may create a very large .BI file.

Besides maintaining the overall integrity of a database, transaction processing is useful in implementing electronic forms. Automation of forms often involves several relational files, calculations, and multiple table look-ups. Typically, many records and memory variables are changed in the process, so an applications developer cannot easily give the user an instant exit capability. Placing the form entry program within a transaction block, however, is all that is required in PROGRESS. If the Escape key is pressed anytime within the form entry transaction block, all changes to data files or memory variables are automatically undone. With a little extra effort, the developer can create PROGRESS applications in which the Escape key always brings the user gracefully back to a menu or logical application juncture.

TABLE 1: *Field Types and Storage Requirements*

DATA TYPE	VALUES	STORAGE (in bytes)
Character	1 to 255 characters	1 + number of characters, excluding trailing blanks. If string is greater than 240 characters, add 2.
Date	1/1/32768 B.C. to 12/31/32767 A.D.	3
Decimal	50 digits with up to 10 decimal places	zero: 1 nonzero: 2 + (number of significant digits + 1) / 2
Integer	−2,147,483,648 to 2,147,483,647	Up to 0: 1 +127: 2 +32,767: 3 +24,000,000: 4 +2 billion: 5
Logical	True or False	True 2 False 1

All fields of a record are of variable length and can be character, date, integer, decimal, or logical, with arrays supported for all types. Large comment fields can be specified without consuming the maximum storage these fields could represent.

DICTIONARY

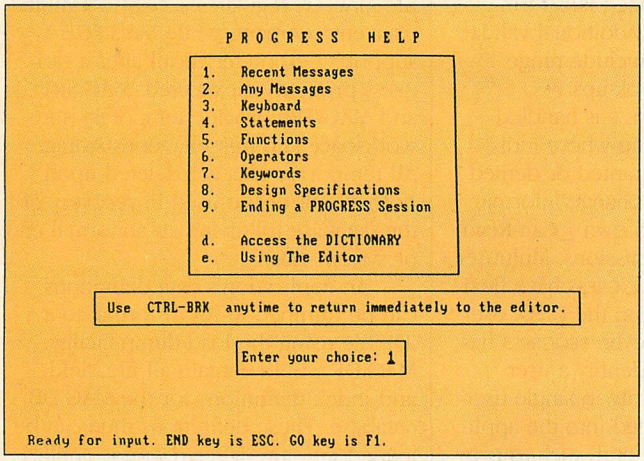
The dictionary is accessed from the PROGRESS editor by way of the help facility. Function key F2, pressed while editing, invokes the help menu shown in photo 1. From this multipurpose menu the user is able to enter the dictionary as well as gather additional information on recent error messages, command syntax, and the editor. When the user is finished with the help menu, the program returns to its location before the menu was invoked.

PROGRESS performs all dictionary functions, including displaying and changing data definitions, printing a dictionary report, loading and dumping of data files, and modifying data security. The dictionary is useful for such mundane tasks as verifying a file's field names, but it has a greater value when used in conjunction with its dynamic nature. Because fields are stored with variable lengths, an application's file definitions, fields, and indexes can be added, renamed, deleted, or modified without dumping and reloading data. The dictionary protects primary indexes or their component fields from being accidentally deleted. Before the primary index can be deleted a new index must be declared primary. Additionally, PROGRESS automatically checks shortened field definitions against the database to avoid inadvertent truncation of data. If truncation is detected, all field update requests made in the same session are undone. This overreaction in error handling requires the remaining valid field changes of an editing session to be reentered. However, in most cases these safeguards are unimposing.

The main PROGRESS dictionary screen reveals four options: display/change data definitions, print data dictionary reports, load/dump data files, and change/query data security. The first of these options is selected when the user is designing an application. It is used to create, delete, or rename files, define their fields, and specify indexes. Simply entering an undefined file name generates a PROGRESS prompt asking if a new file is to be created. PROGRESS then adds an empty file to the dictionary and proceeds to the field and index definition menu. This second menu contains file delete, rename, and copy facilities and an option to undo changes to a file's definitions.

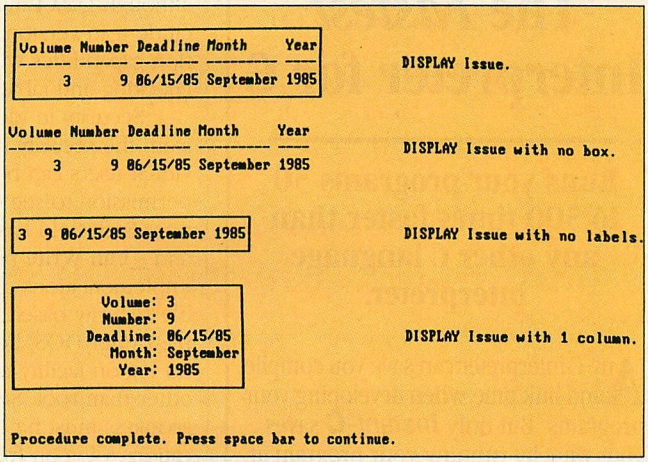
Nine parameters define a field and control its properties, such as type, display format, alternate label, and whether it is an array. Because the developer can make changes to these definitions freely, final adjustments in field width or labeling are simplified. As was

PHOTO 1: *The Help Menu*



Besides allowing the developer to get more information on recent error messages, command syntax, and using the editor, the help menu also allows entry to the dictionary.

PHOTO 2: *Displaying Data*



Using the dictionary definitions, DISPLAY, with its various parameters, can determine field names, labels, display format, and the order in which fields are to be displayed.

PHOTOGRAPHS • CHRISTINE ARMSTRONG/BLAKESLEE-LANE

noted above, an application's field definitions can be added or deleted without reloading the data files.

A field name can be 12 characters long and must start with an alphabetic character. If a field name is unique to the database, then use of that name is an unambiguous reference to that file. In the sample application, Listing is a field name that belongs exclusively to the Article file. Using Listing in a PROGRESS program is an absolute reference to Article.Listing. Volume and Number are fields in both the Article and Issue files, however. If they are used within a block in which both files are active, they must be differentiated: Article.Volume and Issue.Volume. The PROGRESS compiler reports such ambiguities automatically, which are corrected by renaming one field or prefixing the field's name with the file name.

With a little care in naming fields, most file relationships can be reduced to the more compact OF operator. File relationships conventionally specified by Boolean expressions such as

```
FOR EACH article
  WHERE  Issue.Volume = Article.Volume
  AND    Issue.Number = Article.Number:
```

are more simply expressed as

```
FOR EACH Article OF Issue:
```

PROGRESS can use the OF operator on any two files with related fields that share the same name.

A file is unlimited in the number of fields it may contain. Any number can be defined up to a maximum record size of 2,000 bytes. If this limit is reached, files can be split and related one-to-one using the OF operator.

After a field is named, the user specifies its data type. Character, integer, decimal, and logical types are valid. Because character field lengths are variable, the field definition simply specifies maximum display length. Integers are suitable for all whole numbers from −2,147,483,648 to 2,147,483,647, while decimals can have 50 digits with up to 10 decimal digits. If a field is decimal, the developer is prompted for the number of digits to the right of the decimal point. Logical fields can be assigned values other than yes/no or true/false. This permits such pairings as arrival/departure or shipped/not-shipped.

Default output of field value can be controlled using the Format field definition entry. Numeric values can be displayed with or without leading zeros, marked with units such as $, and punctuated by commas. Character field formats are limited to defining the displayed field length. This means that PROGRESS has no straightforward way to include characters that are not part of the field, such as the dashes in a Social Security Number (xxx-xx-xxxx) or the parentheses around the area code of a phone number.

PROGRESS programs do not have to specify field labels each time they display fields. The compiler looks to the label description or, if a label is not specified, the field name itself for labeling information. Invalid field names such as key words can be used to label fields on a display. For example,

```
Field-Name: Todays-date
Label: Date
```

labels all prompts and displays of Todays-date field with Date. Date could not have been used as a field name because it is also a function name that returns the system date.

Initial (or default) values can be defined for each field. When a record is created these default values are automatically assigned, but they can be overridden during data entry. Providing defaults for fields such as State or City can speed data entry considerably in local or metropolitan operations.

A *Mandatory* descriptor can specify fields that must receive data. Before a user can complete data entry, all such Mandatory fields must be entered.

The *Order* value determines the order in which the fields are displayed. Each field is automatically assigned a multiple of 10 as its Order. A field can be inserted between other fields by giving it an Order between the values of the two fields, in much the same way that lines are inserted into a BASIC program. A field that has an Order of 25, for example, would be placed between fields of Order 20 and 30. In *PC Tech Journal's* sample application, this feature was used to insert a second address line. PROGRESS does not provide a facility that automatically renumbers a record's Order sequence.

Any field can be transformed into an array by specifying an *Extent* (the maximum number of elements) greater than zero. Arrays have a traditional syntax **field-name[n]**, where *n* is the element number. Array elements behave like any other field of their type. Array fields cannot, however, be indexed. Segments of an array can be specified using the syntax **field-name[n for m]**, which indicates a range of *m* elements starting from the *n*th element.

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PROGRESS

PROGRESS 2.3d has no field descriptor for providing context-sensitive help, although Data Language plans to include it in version 3. Additional validation capabilities will include range checking and table look-ups.

Security in PROGRESS is handled from the security menu where individual users can be granted or denied permission to see or change information. Each field has its own **_Can-Read** and **_Can-Write** permissions. Multiuser implementations of PROGRESS have flexible security based upon the UNIX user ID. Under DOS, however, PROGRESS has no log-on facility to identify a user other than root. Security in single-user PROGRESS must be coded into the application. A log-on front end, such as provided in R:Base, is not available.

All PROGRESS databases are created from a database called EMPTY.DB or copied from a live database. The first step in developing the sample application was to enter the command: **prodb mag empty**, which created an empty database file called MAG.DB (for *magazine*) from the file EMPTY.DB.

The file EMPTY.DB is not really empty. It contains PROGRESS's relational metaschema, four PROGRESS files hidden from view and manipulated by the data dictionary. When a file is created using the dictionary, its name, field specifications, and index definitions are stored in the metaschema. Each user application file has a corresponding File record and as many Field records as defined fields. The metaschema holds only the file definitions; data are stored in records within the .DB database file.

The EMPTY.DB database is locked, thus preventing modifications to metaschema files, fields, or indexes. The definitions, or *schema*, of a finished application also can be locked with a utility provided with the optional Developer's Toolkit. This is useful for managing program versions or protecting an application from modification. For those interested in tweaking PROGRESS at the lowest level, an unlocked EMPTY.DB and its schema are provided in the Toolkit.

Logical data files of a PROGRESS application are stored within a single physical DOS file (figure 1). The logical files Author, Article, and Issue of the sample application are stored within the physical file MAG.DB. A log file of usage and system messages including start and stop times and any system crashes is kept in MAG.LG. While the database is in use several files are created automatically that support PROGRESS features. The before image (MAG.BI) and local before image (MAG.LBI) files keep record and memory variable histories and are fundamental to crash recovery. The lock file MAG.LK regulates access in a multiuser environment, while MAG.PGE supports edit buffer recall after a PROGRESS program is executed. MAG.SRT and MAG.TRP provide temporary sort workspace and miscellaneous storage. All temporary files are deleted upon normal exit or are used in recovery of the database following an abnormal end or system crash.

An application's data definitions can be dumped in ASCII format to a .DF file using the load/dump facility. MAG.DF would contain all file, field, and index definitions for the MAG.DB database. These definitions then can be loaded into any other database application. If the user is designing an application in modules, the definitions of these modules can be moved into the delivery database individually.

The data are output in ASCII format delimited by quotation marks in files with the extension .D. Once dumped, AUTHOR.D, ARTICLE.D, and ISSUE.D files contain all data of the MAG.DB sample application.

File data can also be dumped from the dictionary's load/dump menu. In some cases PROGRESS does not compress character fields correctly. The stripping of trailing blanks is overlooked when data are assigned to the character field as a result of a function. For example, if a character field **mystring** is defined to have a length of 40, and **anumber** is an integer, then the assignment

```
mystring = "any old yarn" +
  string(anumber)
```

results in a 40-character field. No stripping of trailing blanks is done.

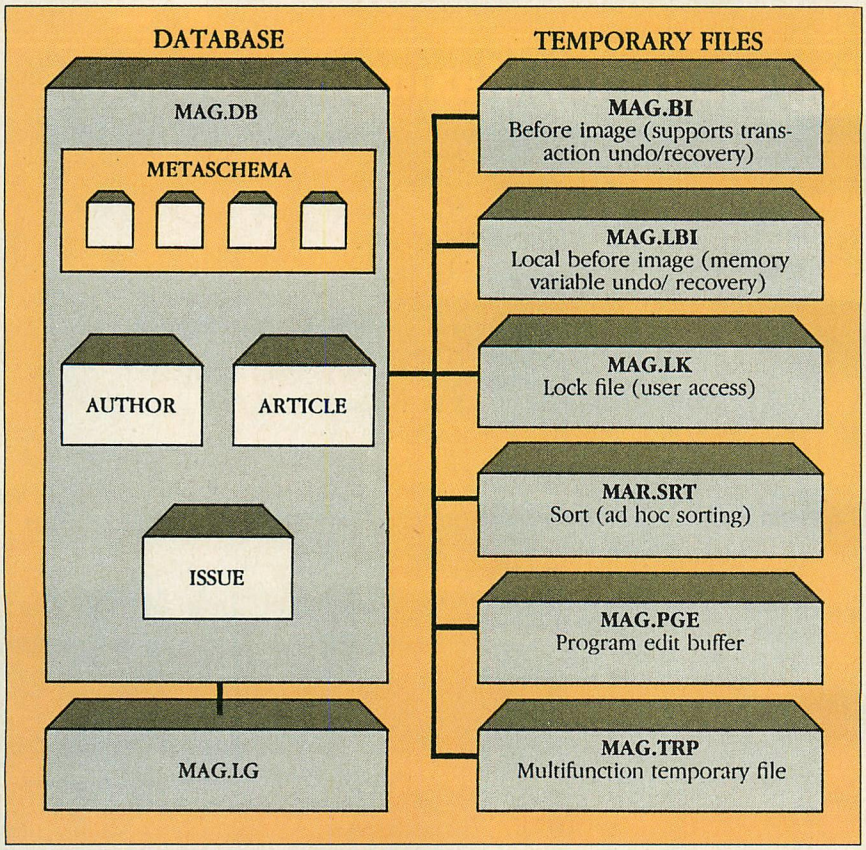
The dump/reload facility in the data dictionary corrects this and should be performed regularly upon databases where this dysfunction presents a problem. Dumping and reloading takes time, however, and is a static fix to what should happen dynamically.

Dumping and rebuilding an application from its .DF and .D files involve five steps: (1) dump the application dictionary; (2) dump the application data; (3) create an empty database; (4) load the application dictionary; (5) load the application data. Applications that are recreated in this way are often smaller in size and usually perform faster than their predecessor. The command

```
prodb <new database> <old database>
```

also makes a copy of an application, but it does not realize any savings in either size or speed.

FIGURE 1: *PROGRESS Files*



The logical files Author, Article, and Issue are stored within the physical file MAG.DB. A log file of usage and system messages is kept in MAG.LG. Temporary files are deleted upon exit or used in database recovery after an abnormal end.

THE PROGRESS EDITOR

Data Language has made the PROGRESS editor a backdrop to all other database activity. Entering PROGRESS is essentially the same as entering the editor. Unlike most data managers, in which the prompt/command line interfaces resemble those of DOS, all PROGRESS commands are typed directly into the editor and executed with the F1 or GO key. This is critical in achieving PROGRESS's level of integration, because after the command is executed, including dictionary calls or program executions, control is returned to the editor.

The editor, from which help can be called, is suitable for almost all program development. Programs can be loaded from disk or recalled from the program execution buffer. This gives developers a chance to explore an unexpected outcome while still retaining immediate access to their source. A typical scenario: a developer executes a program and discovers an error; by recalling the program, making an edit or dictionary change, and executing again, the programmer has participated in the edit/run/debug cycle without changing the source file. If the results of such an investigation are successful, then the new version of the program can be saved. If, as is sometimes the case, the edits are degenerative, they can be cleared and the original program restored in just three key presses.

This full-screen editor is line oriented. Lines can be inserted, deleted, and split. Blocks of lines can be moved, deleted, or copied out to a DOS file. PROGRESS's editor has enhancements over typical line editors. For example, in harmony with the structured language, the editor has a floating left margin. Tabbing in to a nested block is not necessary because a line's left margin is equal to that of its preceding line. A search facility is provided, which reveals the editor's only visible weakness. Searches have no replace option.

An application's data entry, sorting and indexing, and reports are controlled through the PROGRESS language and dictionary. Because these two modules are combined in an integrated environment, changes made in either one can affect the ways data are displayed, retrieved, or processed.

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Technical Bulletin
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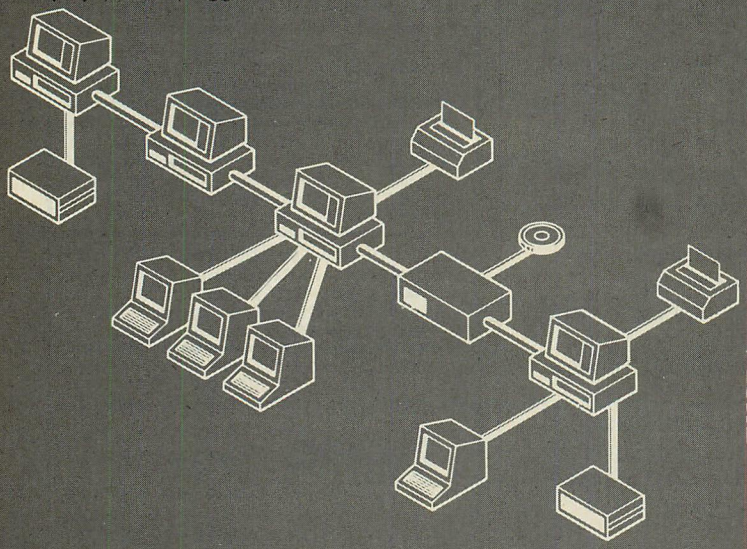
O/S	Computer	Processor	Measured time
QNX ™	IBM-PC AT	80286	480 usec
XENIX ™	Intel-286	80286	4,930 usec

File Security:

Designed with extensive file security features, QNX 2.0 provides login protection with network wide file permission checking based on 255 groups of 255 users. In addition, each PC user may control network access to devices attached locally to their machine.

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As mentioned before, the basic processing entity in the PROGRESS language is the block. Blocks may be nested within blocks. A data display form called a *frame* exists for each block. Many PROGRESS commands are extremely powerful. For example, the DISPLAY statement performs a number of steps automatically. Through the dictionary definitions, DISPLAY can determine a file's field names, labels, display format, and the order in which fields are displayed. Screen space for these fields in the current frame is allocated, and the labels and data are displayed within a surrounding box.

Extensive options are available to the user for presenting the data within the frame; these include displaying the fields in columns, without labels, without the surrounding box, and beginning at a specific row and column number. Photo 2 shows various ways of displaying one record of the Issue file; the PROGRESS statements that were used to invoke these images are printed next to each frame.

The PROGRESS compiler supports global, shared, and local variables. Procedures may call procedures. Because variables of the same name but at separate levels of nesting are differentiated by PROGRESS, recursion is supported. The number of recursive iterations or levels of procedures is limited to a maximum of 50 nested blocks.

The compiler is invoked by pressing function key F1 (GO). Compiled procedures, indicated by .R extensions, can be mixed with uncompiled programs. Programs can also be compiled and saved from within other programs using the command **compile <program name> save**. In PROGRESS version 3, the compiler will be able to accept parameterized include files. If an error occurs during compilation, PROGRESS attempts to place the cursor as close to the culprit as possible. The help menu can immediately be invoked for dictionary, language syntax, and system message questions, so the edit/run/debug cycle is shortened considerably. Changes such as adding a missing index or modifying a field definition can be made to the dictionary quickly. The developer is not obstructed from making changes in the dictionary while programming.

No single-step mode is provided for runtime debugging. This forces the developer to resort to his own program breaks while stalking an error in logic. Syntax or compile time errors do not contribute to this problem, because PROGRESS identifies their origin with a great deal of consistency.

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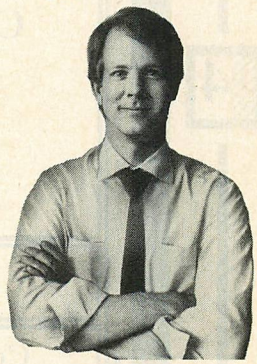
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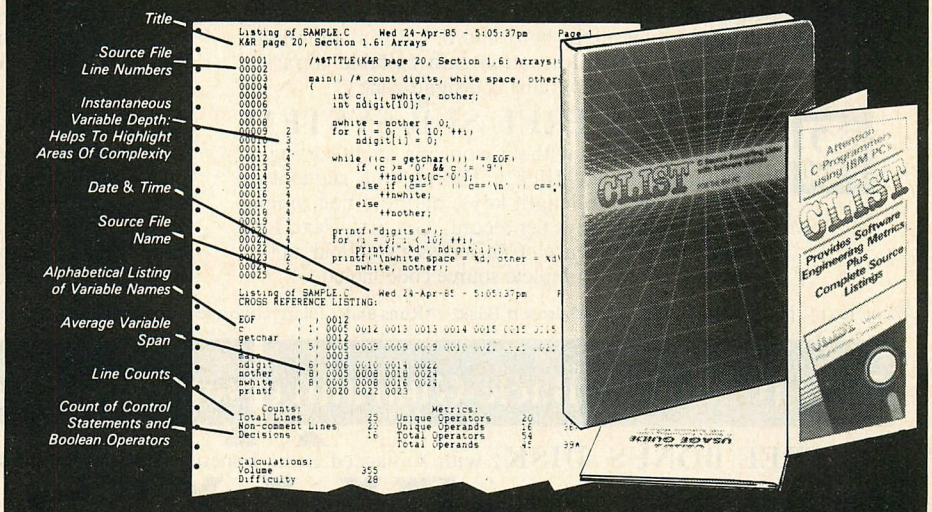
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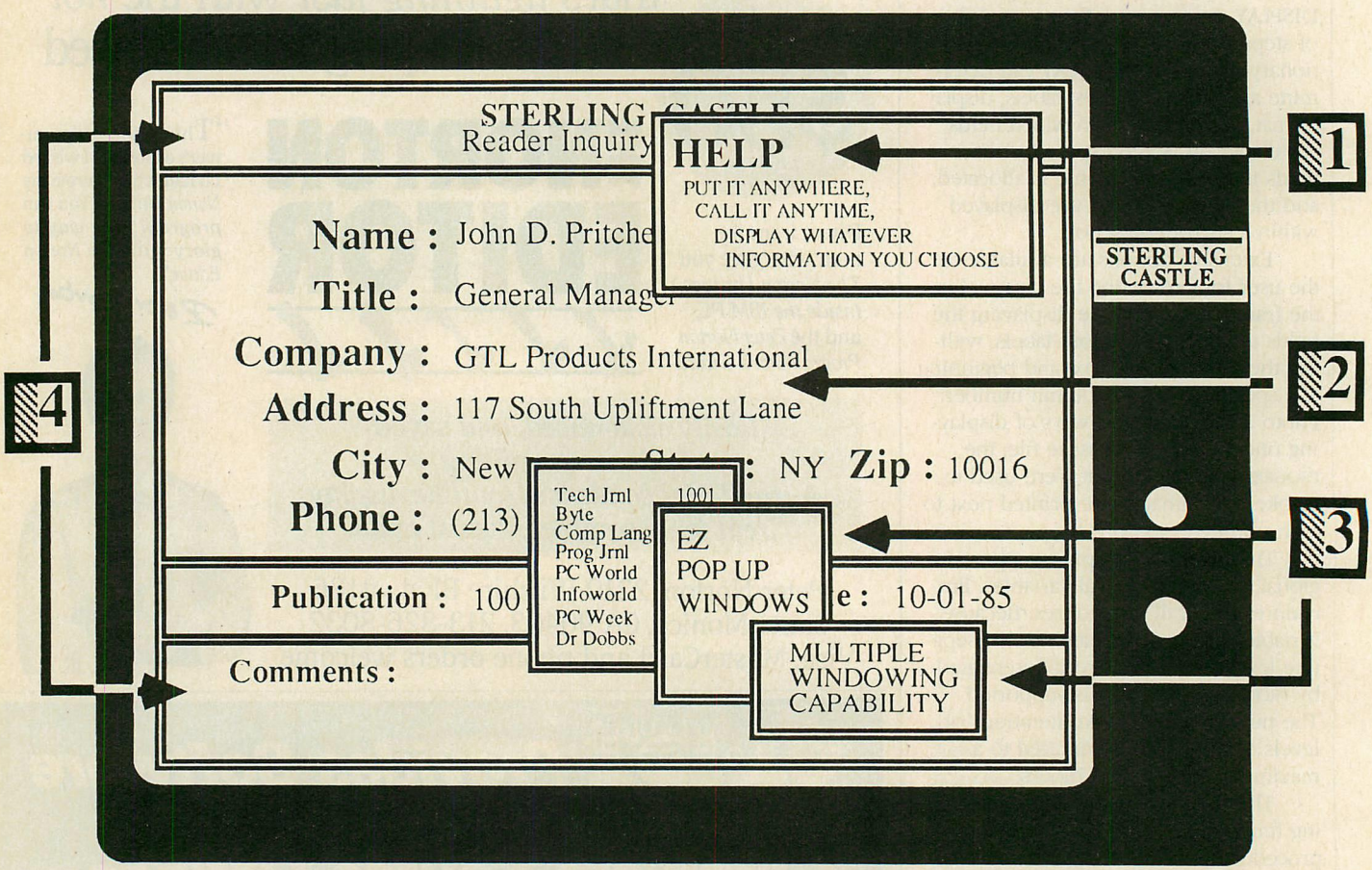
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STATEMENTS AND FUNCTIONS

PROGRESS documentation includes a reference section describing 45 statements and 60 functions and operators in detail. Many of these commands can be manipulated by modifying phrases, giving the developer flexibility in controlling an application at a low level.

In addition to the record-manipulating statements, CREATE (add a record with default initial values), DELETE (remove a record), and DISPLAY, PROGRESS provides other macro-like statements that combine multiple commands into one. SET replaces PROMPT-FOR and ASSIGN, UPDATE performs a DISPLAY and SET, and INSERT combines CREATE and UPDATE. Each record added in this manner is automatically checked for duplicates where the indexed value is defined to be unique.

For processing several records of a file at once, PROGRESS allows specification of a record buffer.

```
DEFINE BUFFER
  <buffer name> FOR <file name>.
```

Multiple records of the same file can be compared using lines such as:

```
IF buffername.field1 < filename.field1
  THEN...
```

Memory variables must also be defined and can be assigned initial values, display formats, alternate display labels, and an array dimension. The statement

```
DEFINE VARIABLE x AS INTEGER FORMAT
  "->>,>>9" EXTENT 10.
```

initializes an array of integers 10 deep. Memory variables can be declared as local, global, or shared. Variables and fields can be passed as parameters to a called procedure. A procedure that accepts arguments passed from a calling procedure must be compiled each time that it is called.

In addition to the traditional IF/THEN/ELSE branching, PROGRESS supports control of active transaction blocks using UNDO, RETRY, and LEAVE. This gives applications developers the ability to undo changes within a transaction at any time. PROGRESS programming, as a result, takes on an optimistic flavor—changes to files are made as if valid until proven otherwise. Banking records in memory variables is not necessary, because all file changes within a PROGRESS transaction can be undone.

Three looping blocks—REPEAT, FOR EACH, and DO—perform a variation of conventional looping. The REPEAT loop has default undo and error processing and transaction back-out. The FOR EACH loop adds record reading. Although the DO loop has none of the default properties, it can be enhanced incrementally to include some or all of the REPEAT loop's properties.

Statistics (AVERAGE, COUNT, MAXIMUM, MINIMUM, and TOTAL) can be ACCUMULATEd on fields, variables, and expressions within a looping program block. Aggregate values are returned using the ACCUM function.

Data can be easily moved into and out of a PROGRESS application using the INPUT FROM and OUTPUT TO statements. On UNIX systems that support true piping, INPUT THROUGH and OUTPUT THROUGH functions are also available options. Directing a report to a printer, file, or port is simple:

```
OUTPUT TO printer.
INPUT FROM "myfile".
OUTPUT TO com2.
```

A number of modifying phrases are available to control echoing of data, page formatting output (including changing page length), or choosing unbuffered input.

More than 40 functions extend the capabilities of the PROGRESS language. Beyond the expected system DATE and TIME, PROGRESS functions also return operating system version (UNIX or MSDOS) or search directory paths for files. Mathematical functions, including log, square root, and modulo, can participate in equations. The 8087 math coprocessor is not supported. String functions can appear within concatenations or within a special VALUE function that returns the character value of an expression. For example, if the variables **command** and **parameter** have been defined as character, then

```
command = "dir ".
parameter = "a:".
DOS VALUE(command + parameter).
```

will obediently perform a directory of drive A:. The VALUE function can be used with INPUT FROM and OUTPUT TO as well, giving the developer a means of placing operating-system-specific parameters under program control. The UNIX command "**ls** " can be assigned to the variable **command**:

```
if OPSYS = "UNIX"
    then command = "ls ". /* UNIX */
    else command = "dir ". /* MSDOS */
```

When used alone, the DOS function invokes a DOS shell on top of PROGRESS. Almost 200KB of free memory is available on a 640KB system. Virtually any standard DOS program, except those that stay resident after termination, can run in this shell. Programs

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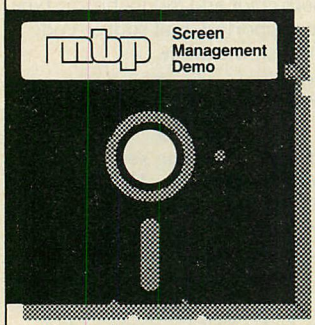
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PROGRESS

such as the DOS PRINT command, which claim a portion of RAM for buffering, should be run before entering PROGRESS. Otherwise, PROGRESS will have a noncontiguous RAM pool and will generate an "**stget out of storage" error message even though the system RAM is quite adequate.

When used with OUTPUT TO, printer attributes such as bold or compressed print can be sent easily. Control codes are described as octal numbers preceded by a tilde (~). The program

```
OUTPUT TO PRINTER.
display "~017". /*~017 = 15 decimal */
```

sets an IBM-compatible dot-matrix printer to compressed print mode.

The PROGRESS database has an enhanced understanding of relationships between files. One-to-many and many-to-one relationships are defined informally and naturally by shared field names. Any related files whose common fields are given the same name can be described naturally using the OF phrase. This PROGRESS program from the sample application locates the issue of a given article and then displays all the articles published in that issue:

```
FIND Issue OF Article.
FOR EACH Article OF Issue:
    DISPLAY Article.
```

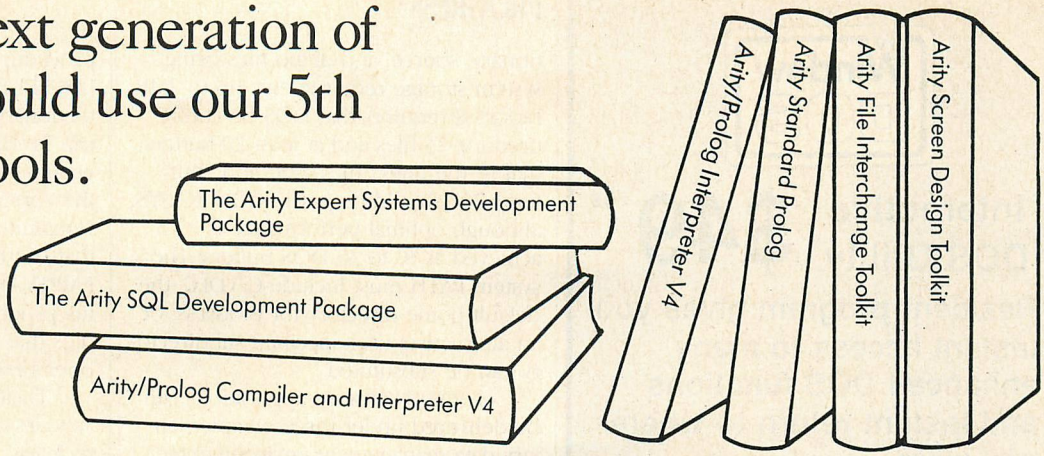
Each file that is in use within a PROGRESS program block has a corresponding active record stored in a record buffer area. The user can select a record buffer area up to 31KB, which presents the only limit to the number of files that can be open at one time. Exiting to another program module closes all record buffers (files) not in use.

Other than the powerful screen formatting commands and the ease of relating files, the user is given no means of producing reports without programming. A report builder is missing from PROGRESS 2.3d, forcing developers to create utilities. PROGRESS version 3 will allow automatic Ctrl-Breaks on fields to execute routines or to allow PROGRESS to subtotal values.

END-USER FACTORS

PROGRESS is installed easily onto a hard disk from four diskettes that are not copy protected. The installation program, INSTALL.BAT, allows specification of a directory to hold PROGRESS, although the default C:\DLC is recommended. Dozens of example programs, once run, should be deleted from systems in which storage space is a problem. The PROGRESS program is less than 350KB in size, but the on-line help, dic-

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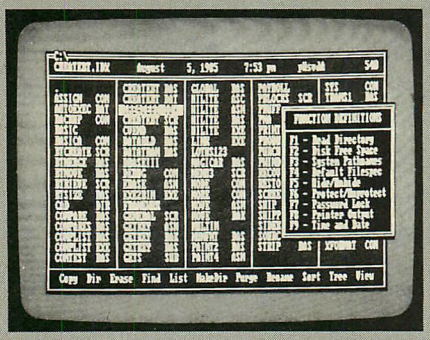
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tionary, source, and demo files bring system storage requirements up to 2MB. PROGRESS requires that DOS be configured for 23 files and at least 20 buffers; that is, the lines "files=23" and "buffers=20" should be put in CONFIG.SYS, although optimal performance is achieved at 30 to 35 DOS buffers. The system PATH must include C:\DLC, the default home directory for PROGRESS, or an alternative, user-specified subdirectory can be substituted.

PROGRESS software applications can be delivered under three complementary data management environments: full PROGRESS, QUERY/RUNTIME, and RUNTIME. Each configuration provides different levels of data, application, and source-code protection. By selecting the environment, applications developers can control with much flexibility the degree to which their data management system will be open or closed.

With full PROGRESS the user can make direct updates to data, change any unlocked portion of the application dictionary, and make modifications to source code. This access can be restricted by compiling some or all of the procedures and freezing the dictionary. If the entire dictionary is frozen, file definitions can be added, but preexisting definitions cannot be changed.

QUERY/RUNTIME is preferred for systems in which end-user files are interrelated and changes to them from outside of the application undesirable. The user is given read access to all of an application's data files. Data can be dumped, reports and tabulations created, and ad hoc queries performed. QUERY/RUNTIME is almost identical to PROGRESS, except that the file create and delete menu options are omitted from the dictionary. Unlike full PROGRESS, however, procedures that change data cannot be compiled under QUERY/RUNTIME. Developers must compile their applications under PROGRESS and move these procedures to a QUERY/RUNTIME application. This is very effective in giving the user a safe interface to data.

The highest degree of application security is afforded by RUNTIME PROGRESS, which executes only compiled programs. Compiled .R files of an application and the database .DB file, are moved from full PROGRESS to RUNTIME. RUNTIME is less expensive, occupies less than 400KB of disk storage, and keeps data and logic under application control away from the end user.

The PROGRESS Developer's Toolkit aids in the delivery of applications. A COMPILE utility is used to create a single program that compiles and saves all procedures of an application. A DBFREEZE utility locks the application dictionary. An application database also can be labeled using DBLABEL, which ensures that compiled procedures of the correct version are being run. The remaining parts include a metaschema that can be modified (an unfrozen EMPTY.DB), a database freeze/label status program, and a number of batch files that can be used to install a developer's PROGRESS application.

Data entry and movement between PROGRESS application modules are easy to learn. Users can move the cursor to any highlighted or underlined data entry fields. Data fields can be edited using the Insert and Delete or Backspace keys and are always checked for validity against the dictionary entry. Automatic checking substitutes error handling code that otherwise might not be practical to include. For example: if 2/29/86 is entered into any date field, PROGRESS will generate an invalid date error because 1986 is not a leap year.

If the PROGRESS developer exercises reasonable care in naming fields, the application's error messages will read naturally. If the application fails to find an author, the PROGRESS-generated error message would be "** Author record not on file." These messages replace most of the error handling coding typically required by vertical market applications and ensure a more consistent user interface. In the event of error, the current programming block is easily undone and retried. If, as in the above example, an author is not found, the user is given the option to edit input or leave. All these error handling, transaction processing, and retry capabilities are provided as PROGRESS defaults in the following program lines:

```
PROMPT-FOR Lastname Firstname.
FIND Author USING Lastname AND
   Firstname.
```

An index can be specified as unique in the PROGRESS dictionary, which prohibits any duplicate records from being added to the file. Again, error reporting is clear:

```
** Author already exists with Lastname
   "Doe" Firstname "John".
```

In reality, two authors can have the same name. The addition of an author number and changing the author name index to not-unique is all that would be required to correct this design limitation of the sample application. Supporting authors of the same name can be performed without dumping data or making major software modifications.

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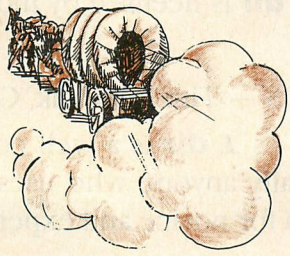
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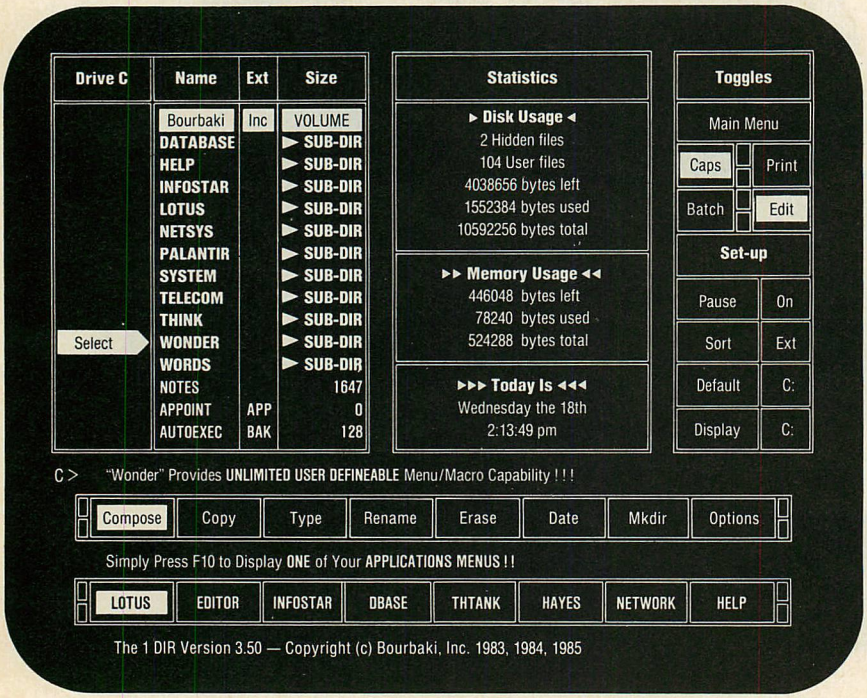
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PROGRESS OVERVIEW

PROGRESS 2.3d
Data Language Corporation, 47 Manning Road, Billerica, MA 01821; 617/663-5000

Product type. A relational data management applications development system that is specifically designed for transaction processing. The integrity of the database is assured through the product's capability to undo the current transaction, as well as to recover after a system crash. Most source code is portable among all systems. The product features an integrated editor, a compiler, help and error reporting, a data dictionary with dump/restore capabilities, and an intelligent display manager. Multiple users are supported in systems other than DOS.

IBM PC environment. PC, PC/XT, or PC/AT running under DOS with a hard disk and at least 512KB of memory. PROGRESS also runs on an AT under XENIX.

Other environments supported. The following UNIX systems are supported: AT&T 7300; DEC VAX 11/780, 11/750, 11/730, and Micro VAX II; Fortune 32:16; NCR Mini Tower, Tower 1632, and Tower XP; Plexus P-15, P-20, P-35, and P-60; AT&T 3B2/300, 3B2/400, and 3B5; Cadmus; Motorola 2000, 6300, and 6600; Sun-2; Burroughs XE550; Pyramid 90XX; and Convergent Technologies Miniframe, Megaframe, and Mightyframe.

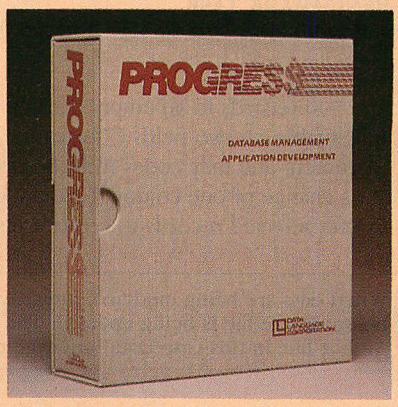
Network support. Networks are not supported by PROGRESS.

Copy protection. The PROGRESS software is not copy protected.

Help facilities. An on-line help facility is available that provides language syntax, gives explanations of recent error messages, lists keyboard program function assignments, and provides help in using the editor.

Documentation. Excellent documentation is supplied with the introduction, tutorial, reference, appendices, and index sections. A hardware-specific "System Management Guide," a "Getting Started" section, on-line tutorial, and sample database are provided.

User interface. Users communicate with PROGRESS through a combination of function keys, menus, and commands. All commands are first entered into the editor, then run by pressing a function key.



File capacities. The database is contained in a single operating system file, which is not otherwise limited in size. The database can hold up to 1,023 files and 1,023 indexes (each file must have one index). The number of files that can be open simultaneously is limited only by the record buffer area (the user defines the record buffer to be from 1KB to 31KB). No limit exists to the number of indexes allowed per file, but each index is limited to 10 fields, or 127 bytes. A maximum of 2,000 bytes is allowed per record; the number of fields is limited only by record size.

Field types and capacities. The character, decimal, and integer fields can vary in length. Arrays are supported for each field type. Date: 1/1/32768 B.C. through 12/31/32767 A.D.; Character: limited only by the input/output line width; Decimal: 50 digits total, up to 10 decimal places; Integer: -2,147,483,648 to 2,147,483,647; Logical: true/false, yes/no, or assignable pairs of values.

Access to system facilities. Commands can be passed to the operating system command line processor.

Data entry. The fully integrated data dictionary permits field definitions and subsequent modification, as well as index additions or deletions without necessitating dump/reload. Fields can be given display formats, default values, and specified as required.

Query and sorting. The optional QUERY/RUNTIME product provides the user with access to the PROGRESS language, while permitting only programs compiled under the full development system to modify data.

Reporting. No separate report facility is provided. However, the PROGRESS language does allow the building of reports with accumulations on fields, variables, and expressions, and provides functions for determining the output line count.

Security. Access to files and fields may be controlled by user ID in multiple user (UNIX) systems. The CAN-DO function tests user permissions on a field. Fingerprinting of a database prevents theft of compiled code.

Utilities. The PROGRESS Developer's Toolkit aids in the delivery of applications. A compile utility creates a single program that can compile and save all procedures of an application. A DBFREEZE utility is provided to lock the applications dictionary. An application database can be labeled using LABEL, which ensures that compiled procedures of the correct version are being run. Also included are a modifiable metaschema (an unfrozen EMPTY.DB), a database freeze/label status program, and a number of batch files that can install a developer's PROGRESS applications.

Applications development facilities. A compiler/interpreter with looping blocks, nested procedures, functions, calls to the operating system command line processor, a sophisticated frame-based display facility, import/export functions, output redirection, parameter passing, global and local variables, shared variables, arrays, multiuser operators, default and declared transaction scoping, source protected compiled delivery, a syntax checker, and on error processing is provided with PROGRESS.

Data compatibility. PROGRESS accepts input from files in which fields are separated by blanks, text strings containing blanks are surrounded by quotes, and quotes in the data are represented by two sets of quotes.

Distribution. Direct sales and dealers.

Price. PROGRESS database/applications development system, $695 (PC DOS) to $19,500 (VAX 11/780); QUERY/RUNTIME, $400 (PC DOS) to $12,000 (VAX 11/780); RUNTIME $200 (PC DOS) to $6,000 (VAX 11/780); Developer's Toolkit $350 (PC-DOS) to $9,750 (VAX 11/780).

Support. An introductory System/Demo is available for $50, and 90-day telephone support is included with product. Introductory and advanced classes are $895 per person. A newsletter and applications catalog also are available to users.

—MK

Adding an author to the database would still be done with the line

INSERT Author.

but the dictionary would be checking the record's author number for its uniqueness, instead.

THE DIFFERENCES

PROGRESS redefines what can be done in one day by an applications developer. The results of the benchmarks of *PC Tech Journal's* sample editorial system are shown in table 2. Two values are shown for each benchmark; the first is the measured time when PROGRESS was invoked without integrity checking (-i); the second column reflects the measured time with integrity checking. In most cases in which data are being modified, integrity checking charges a small price in performance because the before image file is being updated. The biggest difference was in loading the Author file. This is the case in which Data Language recommends integrity checking not be used. The company does recommend backing up the database before loading the data, so recovery is easy in case a problem occurs during the data load.

PROGRESS takes approximately 15 seconds to load. This happens infrequently, however, because the edit/run/debug cycle never exits PROGRESS. On larger multiuser systems, start-up can take two or more minutes. This can be frustrating when moving between applications frequently, but only occurs once a day in delivered applications.

As of yet, no PROGRESS users' groups have formed, so the many tools that can be developed by and for PROGRESS developers lack a means of distribution. Data Language Corporation has a newsletter and is compiling a catalog of vertical market applications that have been developed in PROGRESS.

TABLE 2: *Benchmark Results*

BENCHMARK TASK	TIME (secs)	
	Without data integrity	With data integrity
Add 900 records to an empty database table	139	363
Index table on two fields (7 bytes)	73	79
Document and tally codes from one column	20	19
Mass change of one column (28 rows of 900)	2	10
Extract selected records to create a text file	2	2

When data are being modified, integrity checking hinders performance because the before image file is being updated. The biggest difference shows in loading the Author file; in this case Data Language recommends not using integrity checking.

At this writing, Data Language is conducting beta tests of PROGRESS version 3.0. This new version is a marriage of numerous suggestions by developers and Data Language's own technical goals. Additions include frame modifiers, increased keyboard support, and the capability to spread a database over multiple volumes.

No matter how exciting these new features are, PROGRESS 2.3d and all future versions share the qualities that differentiate it from any other microcomputer data manager on the market today—transaction processing, fourth generation PROGRESS language, automatic crash recovery, dynamic data dictionary, portability, integrated operating environment, and an extremely tight edit/run/debug cycle. Applications are well insulated from hardware dependence and can be transported among a variety of systems safely as separately encrypted ASCII or EBCDIC files. (The dictionary, .DF, .D data files, and source code are 100 percent character data and are all that are required to reconstruct a PROGRESS application).

While delivering fourth generation development technology, Data Language still has managed to preserve the developer's control over an application. Because it is such an effective programming tool and gives its applications qualities whose time has come, Data Language Corporation's PROGRESS may be the sleeper of vertical market and custom software development.

Mark Karaman is an international consultant for Vanguard Computer Services, which is located in Philadelphia.

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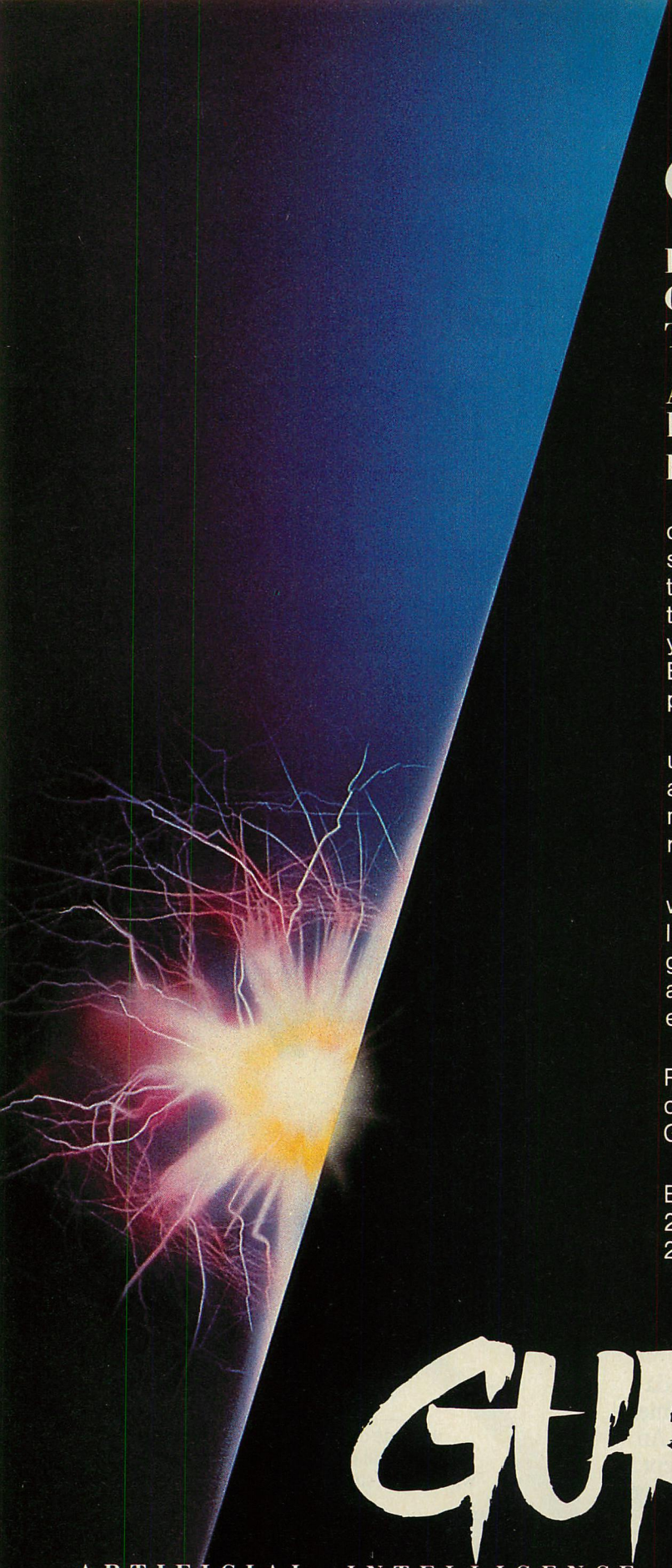
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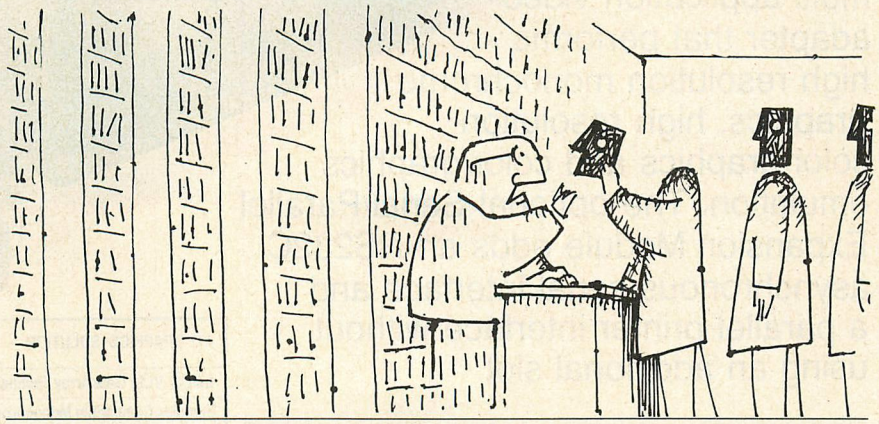


ILLUSTRATION • MACIEK ALBRECHT

In "Improving Turbo's I/O" (Cole Brecheen, September 1985, p. 104) the author discussed many and diverse functions that can be added to Turbo Pascal to increase the language's flexibility. To be added to the list is a library that allows the user to access COMMAND.COM from within Turbo Pascal. The library uses DOS's memory-management functions to free memory for the command processes and for further subprocesses (see figure 1). This collection of subroutines is as simple to use as Turbo's standard procedures and functions, yet it extends the scope of Turbo and makes it a more viable programming environment.

Turbo Pascal is already equipped with some memory-management facilities. Dynamic variables can be created and deleted on the Pascal heap using the standard procedures New, Mark, Release, GetMem, and FreeMem. In addition, a compiled Turbo program can execute other compiled Turbo programs using the standard procedures Chain and Execute. In these instances the transfer of control is permanent. However, when using the routines developed here to work with DOS facilities, Turbo programs can release unneeded memory to the system, instruct DOS to load and run any other executable program, and continue processing after the subprocess is finished.

MANAGING MEMORY

In versions 2.0 and later, DOS maintains memory control blocks, which determine the allocation of each contiguous block of system memory (see "Managing Memory," William J. Redmond, August 1984, p. 42). Some of the memory in this resource pool, such as that occupied by the resident portion of DOS, is permanently withheld from user applications. The remaining memory is allocated to applications or used by the operating system as required. Careful control of memory blocks is essential for multitasking systems and other schemes in which several programs reside in memory at once.

DOS allocates memory to a .COM program in a procedure that requires several steps. First, the largest available block of contiguous memory is allocated to the program. This block usually is comprised of all memory beyond that used by the resident portion of the operating system, including any extensions (such as device drivers, printer buffers, RAM disk simulators, and memory-resident utilities). Multiprogram operating environments such as TopView, however, allocate only a portion of all available memory to the program.

In the second step of this procedure, DOS constructs a program segment prefix (PSP), which contains control information, in the first 100H bytes of the memory block. Next, the program code is placed in the block immediately following the PSP, and, finally, control is transferred to the first word of the program's executable code. The procedure for executing an .EXE program is similar. The difference is that DOS performs relocation when loading the program and allocates only as much memory as is required. IBM suggests that a well-behaved program should release *all* unused memory to the resource pool, freeing it for other uses.

The function calls for memory management that are available with DOS can allocate, deallocate, and reallocate blocks of memory. To call a DOS function, an application loads the function number in the AH register and executes interrupt 21H. If DOS is unable to carry out the request, the carry flag is set and an error code (the meanings of which are explained below) is passed back in the AL register.

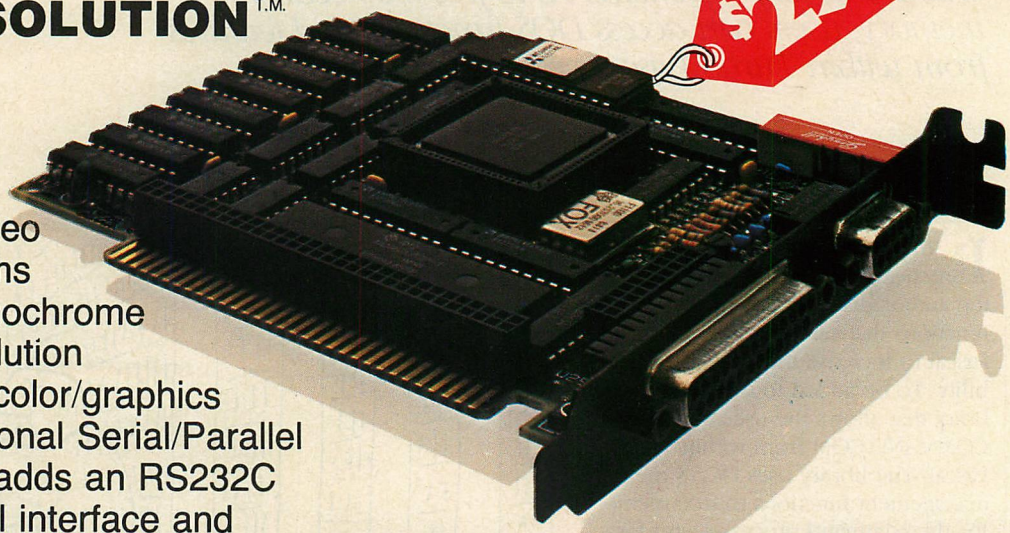
Function call 48H (allocate memory) requests the allocation of a contiguous block of memory that contains the number of 16-byte paragraphs specified in BX. If the amount of memory available for allocation is sufficient to satisfy the request, DOS complies and returns in register AX the segment address of the newly allocated block. If the amount of memory available is not sufficient, DOS returns in register BX the paragraph size of the largest block of memory that is available.

Function call 49H (free allocated memory) instructs DOS to return a previously allocated block of memory to the resource pool. This, in effect, undoes a previous 48H function call. The segment address of the block to be released is placed in ES. When a program is finished, DOS releases only the block of memory originally allocated for that program—an application must explicitly

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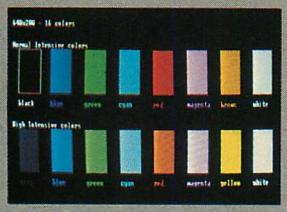
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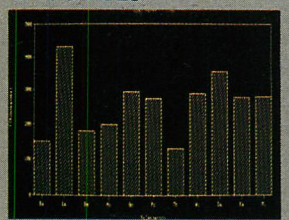
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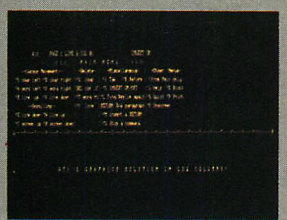
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release all other allocated blocks; otherwise the memory contained in those blocks becomes permanently unavailable to any other application (until the system is rebooted), a situation that can cause a system crash.

Function call 4AH (set block) instructs DOS to resize a memory block and make it either larger or smaller. The segment address of the memory block to be resized is placed in ES. The number of paragraphs required in the block after the reallocation is specified in BX. An allocated block can be made smaller by simply freeing a portion of memory in the block and returning that memory to the resource pool. The user must be certain, however, before using the 4AH function call, that the data stored in the released memory are not necessary to any application. An allocated block can be made larger only when sufficient memory is available immediately above the block's upper limit. In the applications below, 4AH is used to release sufficient memory to allow the loading of a subprocess, thus reducing the size of a memory block.

Two DOS function calls are available to execute subprocesses from within programs after 49H or 4AH have been used to release the required memory. As with the calls discussed above, DOS sets the carry flag if it cannot fulfill the request.

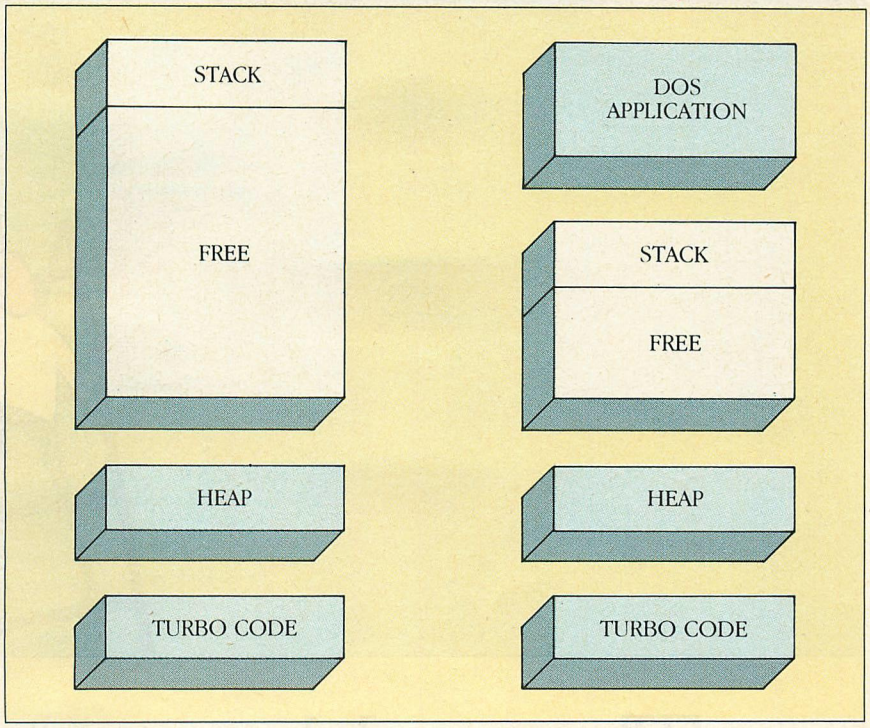
Function call 4BH (load and execute a program) instructs DOS to execute a .COM or a .EXE file as if the name of the program had been typed at the DOS prompt: memory is allocated; a PSP is established; the program code is loaded; and the new application is given control of the system. When the new application finishes (by executing an interrupt 20H, by calling program terminate function 00H or 4CH, or by calling terminate process and remain resident function 31H), control is returned to the parent process and processing is continued.

When using function 4BH, the parent process provides DOS with the name of the program to be executed and with a double-word pointer to a 14-byte load control parameter block that DOS can use to construct a PSP for the subprocess. Any files opened in the parent process are available for use by the subprocess; thus, a calling application can specify redirection of standard input and output in the subprocess by setting up the appropriate logical file assignments prior to requesting 4BH.

Unlike other DOS function calls, 4BH does not preserve values in the registers. An application can preserve the values in most of the registers by pushing their contents onto the 8086 stack before invoking function 4BH. Unfortunately, the values of the SS (stack segment) and SP (stack pointer) registers are altered by 4BH and must be saved in a portion of memory that can be addressed relative to the CS (code segment) register when the parent process resumes processing. If the SS and SP are not saved in this way, the parent process is unable to continue execution when the subprocess finishes, and the system can crash.

Function call 4DH (retrieve the exit code of a subprocess) allows the parent process to obtain status information back from a subprocess. Programs that terminate using either function 31H or 4CH can return an exit code using the AL register. The only way to query this exit code is to call function 4DH. IBM calls this function *wait*; it is evidently intended for multitasking versions of DOS, in which the subprocess and parent process operate concurrently and 4DH is necessary to ensure synchronization between processes.

FIGURE 1: *Making Room for DOS Application*

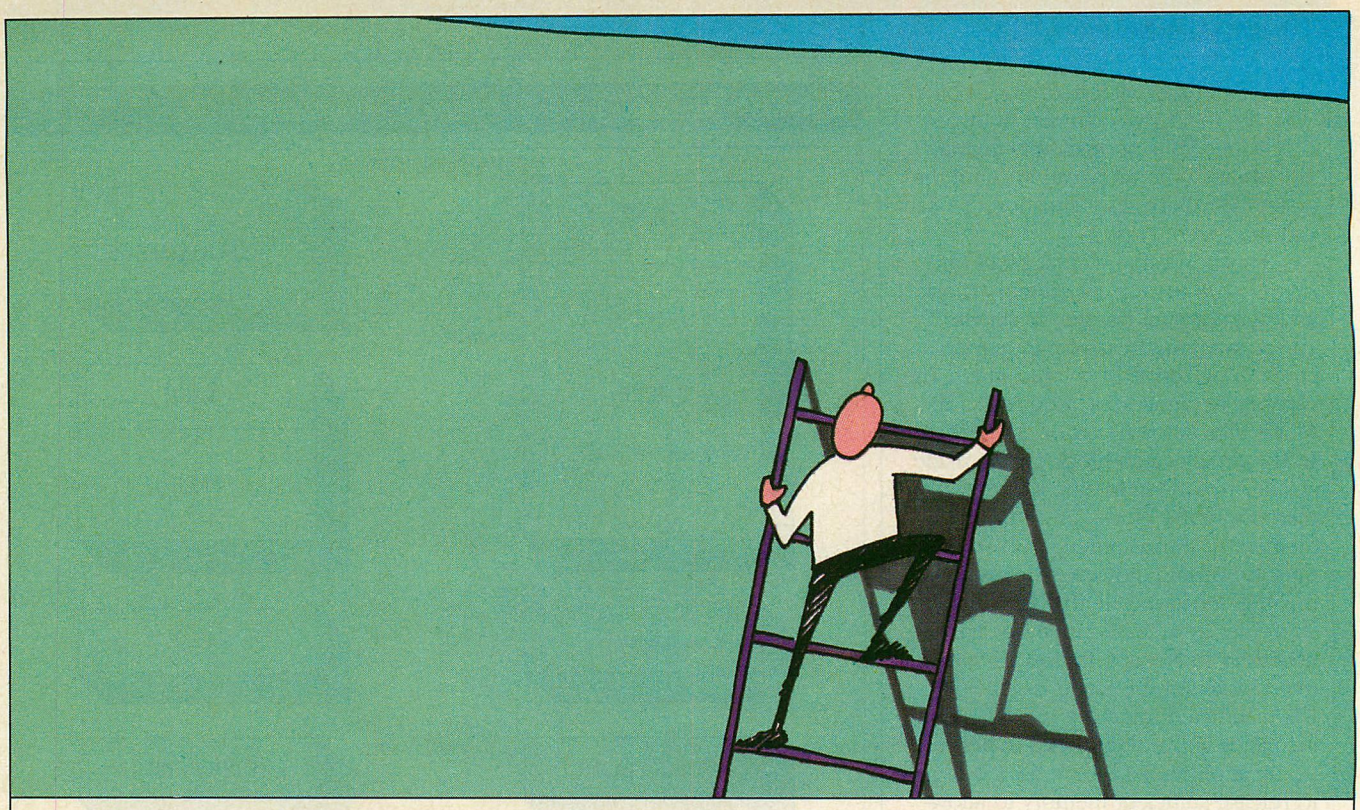


Memory management allows a programmer to reduce the size of Turbo Pascal and make room for a DOS application in high memory. The user can execute DOS commands from a Turbo program then return to the parent application.

INTERFACING TO TURBO

A Turbo Pascal procedure or function that is declared EXTERNAL passes its parameters on the stack. Parameters can be declared either pass-by-value or pass-by-reference, but only pass-by-reference parameters can be altered by an assembly language subroutine. Extensive documentation of the formats used with pass-by-value parameters appears in chapter 20 of Borland International's *Turbo Pascal Reference Manual*. In short, integer pass-by-value parameters are passed using a full word on the stack, while all pass-by-reference parameters are passed by placing a double-word pointer on the stack. External subroutines access the values or addresses of parameters by using the BP (base pointer) register relative to the SS register; the subroutines that are included in the SPMMLIB.PAS library (which is discussed below) use the Microsoft Macro Assembler's STRUC directive to allow the arguments to be referenced by name. External subroutines must preserve the values in the DS, SS, SP, and BP registers, but the values in other registers can be changed. If an external subroutine is declared a function, it can return a function result, typically by placing the value in the AX register.

The executable code for an external subroutine is included as part of the program's code segment and is invoked by using a near call. Thus, when an ex-



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ternal subroutine is given control, the CS register contains the segment address of the entire Pascal program, not the segment address of the start of the subroutine. This creates problems for external subroutines that require local data storage, because the macro assembler generates address offsets relative to the start of the subroutine. As a result, external subroutines using local data must be able to calculate a relocation factor that, when added to the offsets generated by the assembler, yields the correct offsets relative to the start of the Pascal code segment. One method of calculating this relocation factor uses one of the assembly language functions included in the SPMMLIB.PAS library.

The Turbo subprocess and memory-management library (see listing 1 and table 1) contains six subroutines, each of which can be used to access DOS 2.x and 3.x functions through interrupt 21H. Four of these subroutines are written in Pascal.

The integer function DOS48H provides a direct interface with the DOS *48H* (allocate memory) function. This function can be invoked only from a program that has been compiled to a .COM file; if the user attempts to call it from a program compiled directly to memory, DOS can fail and require that the system be rebooted. The integer function DOS49H provides a similar interface with the DOS49H deallocate memory function; it releases blocks of memory that were allocated for use with DOS48H. Both of these functions return a function result of 0 if DOS completes the request, and the DOS error code if the request fails.

The Boolean function called DOS_ERROR_CHECK is a simple utility that interprets error codes. If passed a value of 0, DOS_ERROR_CHECK returns the function result FALSE; if passed any other value, this function displays the corresponding error message and returns the function result TRUE. The integer function DOS4DH provides a direct interface with the DOS 4DH retrieve exit code function, and returns the exit code as its function result. The Boolean function called GET_COMSPEC does not relate directly to memory management; its function is discussed below.

The remaining two subroutines are EXTERNAL functions; thus, only their procedure headings are included in the SPMMLIB.PAS library.

TABLE 1: *Memory Management Calls*

DOS FUNCTIONS USED DIRECTLY
48H Allocate memory
49H Free allocated memory
4DH Get return code of subprocess

DOS FUNCTIONS USED AFTER STACK SAVED
4AH SETBLOCK: Resize allocated memory blocks
4BH EXEC: Load and execute a program

The memory management library (see listing 1) gives Turbo Pascal users direct access to the DOS functions that are shown above. The library called SPMMLIB.PAS accesses the first three with simple interfaces. SETBLOCK and EXEC cannot be used until assembly language subroutines have saved the stack.

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RD    READ "NAME:  ",NAM,! QUIT:NAM=""
      IF NAM'?2.A1","1A.E WRITE "PLEASE ENTER AS LAST, FIRST MI",! GO RD
TEL   READ "TEL #  ",TEL,! IF TEL'?3N1"-"4N WRITE "NNN-NNNN PLEASE",! GO TEL
      SET ^DATA(NAM)=TEL GO RD
PRT   WRITE "    NAME",?20,"TELEPHONE #",! SET NAME=""
LP    SET NAM=$ORDER(^DATA(NAM)) QUIT:NAM=""   WRITE NAM,?20,^DATA(NAM),! GO LP
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The assembly language program of the integer function DOS4AH is shown in listing 2. DOS4AH attempts to shrink the size of the Pascal program's memory block by the number of paragraphs that are passed in the integer argument PP_TO_RELEASE. If the attempt is unsuccessful, DOS4AH returns the DOS error code in the AX register (the function result), which can be interpreted using the DOS_ERROR_CHECK function. If it is able to release the memory, however, DOS4AH must relocate the contents of the Turbo Pascal stack and reset the SS register to a place within the boundaries of the now reduced memory block. This step is necessary because compiled Turbo programs, which are .COM files, are allocated all available memory (including all the memory released by 4AH to DOS) and create a runtime stack at the high end of this memory.

The relocated Turbo stack occupies memory that otherwise would have been used for Turbo's heap (the space allocated to store dynamic variables). Thus, the application calling DOS4AH must be certain that no dynamic variables have been created in the memory space required for the new stack. The best way to guarantee this is to call DOS4AH at the beginning of a program before any heap allocations have been made. After the program is running, Turbo can recognize that its heap space has been reduced and will not attempt to allocate any new dynamic variables to the space occupied by the stack.

DOS4AH can be used only in programs compiled to a .COM file. If invoked from a program compiled directly to memory, DOS4AH fails and returns the error message "memory control blocks destroyed." According to IBM, this leaves the memory allocation system in an unpredictable state, and later can cause a system crash.

The integer function DOS4BH (see listing 3) must be assigned two arguments: a Turbo Pascal string containing the ASCIIZ name of the program to be executed, as well as a Turbo Pascal string containing the unformatted parameter string passed to the program in the PSP. Both of these arguments are declared pass-by-reference in the SPMMLIB.PAS library, and only their double-word addresses are placed on the stack. After calculating an offset relocation factor, DOS4BH constructs a load control parameter block. The segment address of the environment is set to 0; the subprocess is given access to the same environment as the parent process. The FCB address fields are ignored and always set to 0. Next, the SS and SP registers are saved locally, and function 4BH is invoked, which starts the subprocess. After the subprocess terminates, DOS4BH recalculates the relocation factor, restores the SS and SP registers, places the error code or 0 in the AX register, and returns to the calling Turbo Pascal program.

EXECUTING DOS FROM TURBO

Listing 4 shows the Turbo Pascal source code for the program DOSCOM.PAS. The program is straightforward: it uses the SPMMLIB.PAS library to read DOS commands from the keyboard and, by executing a secondary copy of the DOS command processor, is able to act on those commands as if they had been entered at the DOS prompt. Any DOS commands can be executed, even those that invoke other applications programs. If necessary, DOS is even able to search for a required program using the PATH specification in the DOS environment.

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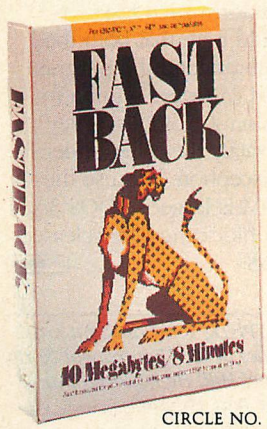
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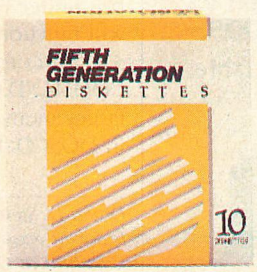
† All times are given in minutes:seconds. [1]Although the TeamMate promised image backup and restore, the image backup option did not work. Therefore, neither of the image options were timed. [2]The Mountain would not work on the standard test machine. Its benchmarks were obtained by connecting it to a PC with a 20 MB Microscience hard disk (which contained 10 MB of data). Fastback time test was conducted by Fifth Generation Systems. Tape Drive table is an excerpt from PC Tech Journal, November 1985 Issue, page 73. Copyright © 1985 Ziff-Davis Publishing Company. These test measure each drive's performance when executing a series of standard tape operations. N/A means that the tape drive does not support that operation.

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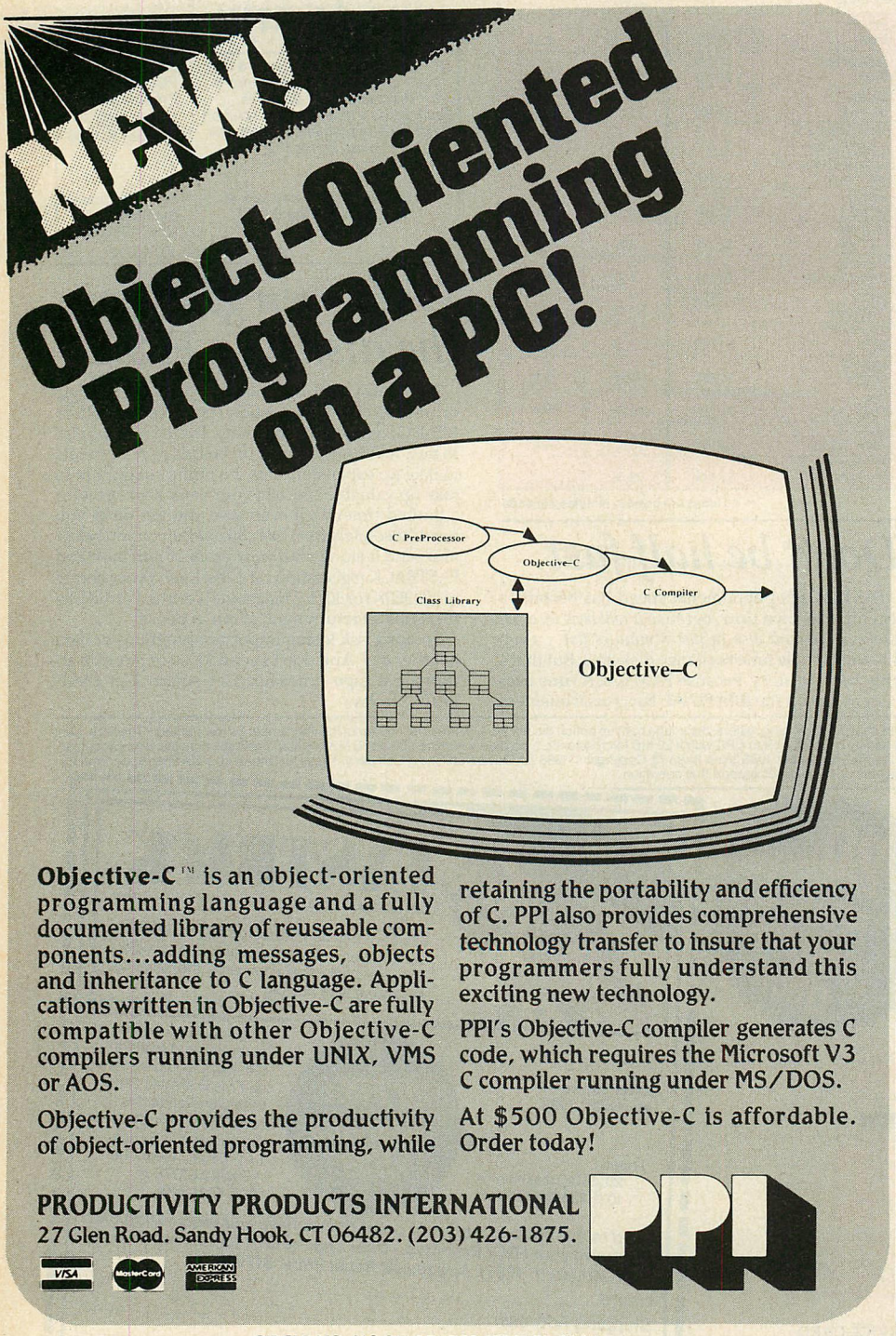
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In addition, commands can include DOS input- and output-redirection characters. If a command results in a change in the DOS environment with, for example, a PATH command, the change remains in effect only until control is returned to DOSCOM.PAS.

DOSCOM.PAS uses the DOS48H function to check for the availability of sufficient unallocated memory. Sufficient memory probably is available if the Pascal program was compiled with the upper limits set on the size of its heap/stack segment. If adequate memory is not available, the DOS4AH function is called to release sufficient memory and relocate the stack. When the required amount of memory is made available, DOSCOM.PAS enters a loop: it reads a command from the keyboard, loads COMMAND.COM (the DOS command processor); and passes it the command to be executed. This loop continues until **bye** is entered as the DOS command, then the memory allocated to COMMAND is freed.



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Before it is able to load the COMMAND.COM program, DOSCOM must find it. GET COMSPEC (mentioned above) searches the COMSPEC specification in the DOS environment (segment address at offset 2CH in the parent process's code segment) and tries to locate the D:[path]filename of the command processor. The pass-by-reference argument of this function is the name of a string that contains the ASCIIZ file name. COMSPEC returns FALSE if no problems arise in its search and TRUE if it is unable to locate the COMSPEC=string in the environment.

Note that one of SPMMLIB's routines is not used in DOSCOM. As a further refinement, the exit code for the executed DOS command could be obtained by a call to DOS4DH after the DOS4BH function is finished.

The DOS command to be executed is passed to DOS4BH as a Pascal string preceded by /C (see *DOS 3.1 Reference Manual*, pp. 7-53) and followed by a carriage return. Approximately 27KB of memory must be released: 23KB for the DOS 3.1 command processor and 4KB for overhead. If the command passed to DOS calls for the execution of some other .COM or .EXE program, enough memory must have been released to allow the program to run.

APPLICATIONS

Effective memory management in Turbo Pascal allows a host of useful applications for both programmers and end users. The SPMMLIB.PAS library and the DOSCOM.PAS code shown in listing 4 can be incorporated into any Turbo program to allow the user to invoke DOS commands directly. Output redirection provides more opportunities: DIR output can be redirected to a file, read from Pascal, and manipulated internally. Programmers can use Turbo to create quick memory-resident programs or DOS shells; in the past, users believed that only C and assembly language could perform such tasks.

Users should note that both the SPMMLIB.PAS library and the program called DOSCOM.PAS were written to run under version 2.1 of DOS. They will function exactly the same under 3.x, with one exception: because the COMMAND.COM is larger in DOS 3.x, a larger memory block must be released in DOSCOM.PAS.

David D. Steiner, Ph.D., is an assistant professor of economics at the University of North Carolina at Chapel Hill. He has been programming for the past 16 years.

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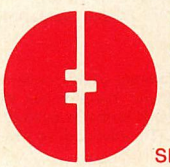
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LISTING 1: SPMMLIB.PAS

```
{-----------------------------------------}
{ SUB-PROCESS AND MEMORY MANAGEMENT LIBRARY }
{-----------------------------------------}
type
   r8086=
      record
      ax,bx,cx,dx,bp,di,si,ds,es,flags:integer;
      end;
   asciiz=string[65];

var regs:r8086;

{ --------------- REDUCE MEMORY ALLOCATION }
function dos4AH(pp_to_release:integer):integer;
   external 'dos4AH.com';

{------------------- EXECUTE A SUB-PROCESS }
function dos4BH(var program_name,parameter_string):integer;
   external 'dos4BH.com';

{-------------- ALLOCATE A NEW MEMORY BLOCK }
function dos48H(pp_needed:integer;var block_segment:integer):integer;

   begin
   regs.bx:=pp_needed;          { # of paragraphs required.   }
   regs.ax:=$48 shl 8;          { Function call 48H.          }
   msdos(regs);                 { Call DOS.                   }
   if (regs.flags and 1)<>0 then { Is carry flag set?         }
      begin
      block_segment:=regs.ax;   { Yes, return available pp's, }
      dos48h:=lo(regs.ax);      { and error number.           }
      end
   else
      begin
      block_segment:=regs.ax;   { No, return segment address, }
      dos48h:=0;                { and error code 0            }
      end;
   end;
```

```
{-------------------- RELEASE A MEMORY BLOCK }
function dos49H(block_segment:integer):integer;

   begin
   regs.es:=block_segment;      { Segment address to release. }
   regs.ax:=$49 shl 8;          { Function call 49H.          }
   msdos(regs);                 { Call DOS.                   }
   if (regs.flags and 1)<>0 then { Is carry flag set?         }
      dos49H:=lo(regs.ax)       { Yes, return error number.   }
   else
      dos49H:=0;                { No, return error code 0.    }
   end;

{--------------- OBTAIN A PROCESS'S EXIT CODE }

function dos4DH:integer;

   begin
   regs.ax:=$4d shl 8;          { Function call 4DH.          }
   msdos(regs);                 { Call DOS.                   }
   dos4dH:=lo(regs.ax);         { Return Exit Code.           }
   end;

{--------------- GET COMMAND PROCESSOR NAME   }
function get_comspec(var comspec:asciiz):boolean;

type
   dos_env_type=array[1..254] of byte;
   dos_env_string=^dos_env_type;

var
   dos_env:dos_env_string;
   dos_envs:string[255];
   idx:integer;

   begin
   get_comspec:=false;
   dos_env:=ptr(memw[cseg:$2c],$0); { Get 254 bytes of the DOS    }
   move(dos_env^,dos_envs[1],254);  {     environment string.     }
   dos_envs[255]:=#0;
```


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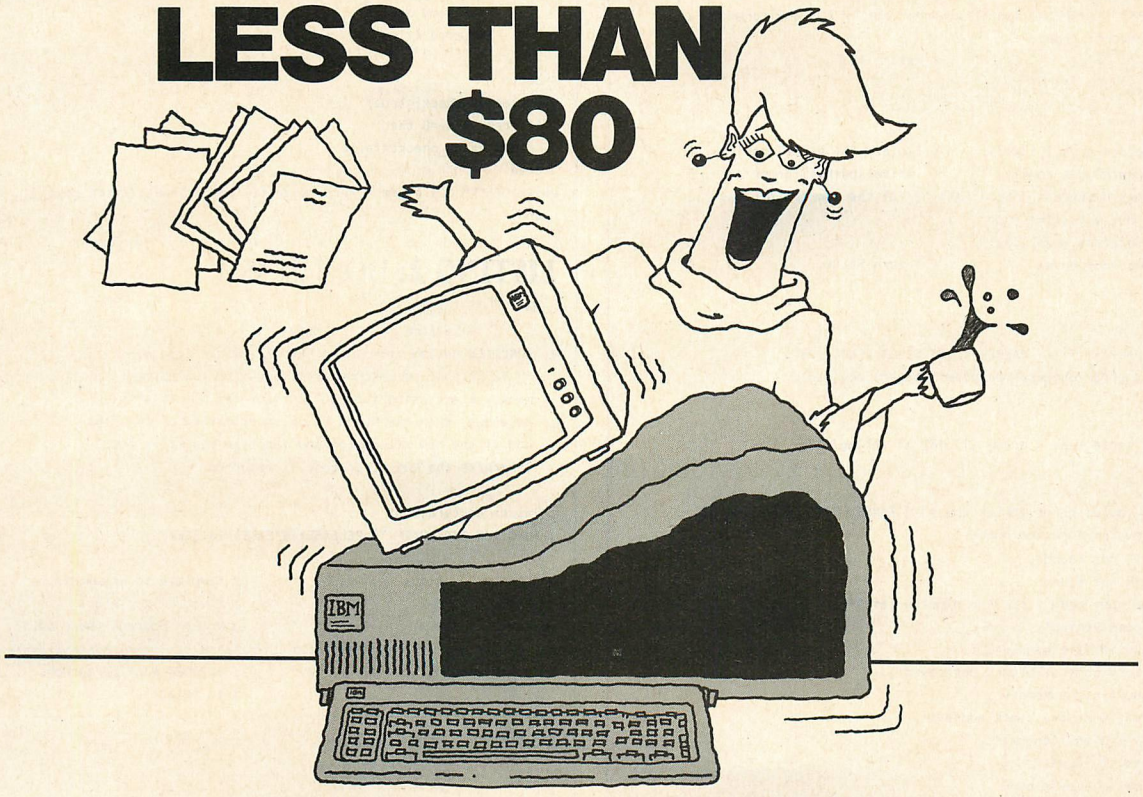
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```
    dos_envs[0]:=#255;
    idx:=pos('COMSPEC=',dos_envs);   { Find COMSPEC= portion.      }
    if idx=0 then                    { Yikes! No COMSPEC= there!   }
     begin
    writeln('*** "COMSPEC=d:[path]filename" not in DOS environment.');
       get_comspec:=true;
       exit;                         { Return TRUE.                }
     end
    else
       begin
       delete(dos_envs,1,idx+7);     { Isolate the ASCIIZ string   }
       idx:=pos(#0,dos_envs);        {  drive:[path]filename       }
       dos_envs:=copy(dos_envs,1,idx); {  of the command processor.}
       while dos_envs[1]=' ' do
          delete(dos_envs,1,1);
       comspec:=dos_envs;            { Return FALSE.               }
       end;
    end;

{---------------------- HANDLE A DOS ERROR CONDITION }
function dos_error_check(error_code:integer):boolean;

    type
       error_table_type = array [1..18] of string[41];

    const
       error_table: error_table_type =  { RANGE: 1 TO 18 DECIMAL }
          ('Invalid function number',
          'File not found',
          'Path not found',
          'Too many open files (no handles left)',
          'Access Denied',
          'Invalid file handle',
          'Memory control blocks destroyed',
          'Insufficient Memory',
          'Invalid memory block address',
          'Invalid environment',
          'Invalid format',
          'Invalid access code',
          'Invalid data',
          'UNRECOGNIZED ERROR',        { NOT USED BY DOS }
          'Invalid drive was specified',
          'Attempted to remove the current directory',
          'Not same device',
          'No more files');

    begin
    dos_error_check:=true;
    if error_code=0 then
       dos_error_check:=false
    else
  writeln('*** DOS error ',error_code,': ',error_table[error_code]);
    end;
```

LISTING 2: DOS4AH.ASM

```
code          segment
              assume       cs:code
;  FUNCTION called from Turbo Pascal, which releases
;  PP_TO_RELEASE paragraphs of memory from the current
;  memory block using the DOS function 4AH. If this is
;  possible, then the Turbo stack is relocated to the high
;  end of the new allocation and function result is zero.
;  Otherwise the DOS error code is returned.

; Pascal declaration:
; FUNCTION DOS4AH(PP_TO_RELEASE:INTEGER):INTEGER;

arguments     struc                    ; Template to arguments.
save_bp       dw       ?               ; Saved BP register.
ret_adr       dw       ?               ; Return address (near call).
;-----------------------------------------------------------------
pp_to_release dw       ?               ; INTEGER # of paragraphs
                                       ; to release.
;-----------------------------------------------------------------
arguments     ends

dos4AH        proc     near
```


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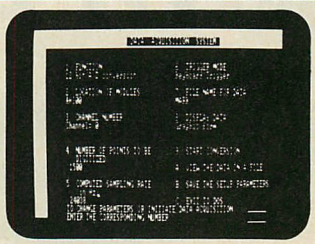
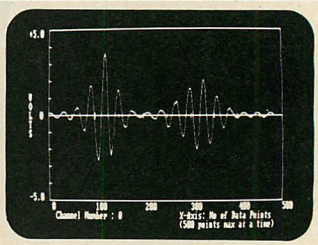
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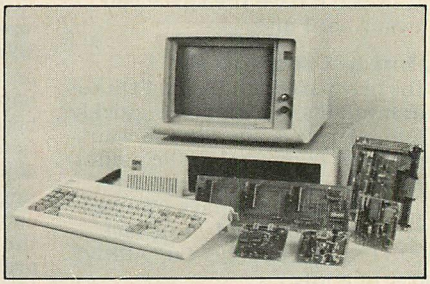



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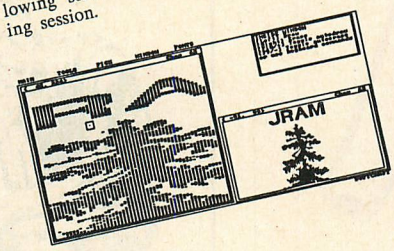
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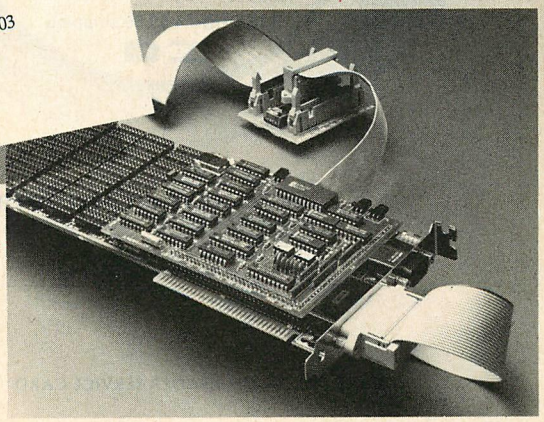
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CIRCLE NO. 197 ON READER SERVICE CARD

```
            push    bp
            mov     bp,sp           ; Establish access to arguments
            push    ds              ; Save Turbo's data segment.

            mov     ax,cs           ; Calculate the paragraph size
            mov     bx,ss           ; of the current block as
            add     bx,1000H        ; SS+1000H minus code segment
            sub     bx,ax           ; address. Then calculate new
                                    ; size for memory block.
            sub     bx,[bp].pp_to_release
            mov     es,ax           ; Segment address of current
            mov     ah,4ah          ; memory block.
            int     21h             ; Ask DOS to deallocate the space.
            mov     ah,0
            jc      exit            ; Was it possible to release
                                    ; the memory?
            mov     ax,ss           ; Yes: set up to relocate stack
            mov     ds,ax           ; DS:SI is pointer to old stack
            sub     ax,[bp].pp_to_release
            mov     es,ax           ; ES:DI is the pointer to
            mov     bx,sp           ; the new stack.
            mov     di,bx
            mov     si,bx

            mov     cx,sp           ; Two's complement of SP
            neg     cx              ; is stack size.
            cld                     ; Move cx bytes from
            rep     movsb           ; DS:SI to ES:DI ...
                                    ; starting with the lowest byte
            mov     ss,ax           ; Change the SS register ...
            xor     ax,ax           ; and set the error code to 0.
exit:       pop     ds
            pop     bp
            ret     4               ; Pop argument and
dos4AH      endp                    ; "function result".
code        ends
            end
```

LISTING 3: DOS4BH.ASM

```
code        segment
            assume      cs:code

; FUNCTION called from Turbo Pascal, executes .COM
; or .EXE programs using the DOS function 4BH.
; Preserves the stack registers, returning the
; error code 0 if succesfull or the DOS error code
; if the execute fails.

; Pascal declaration:
; FUNCTION DOS4BH(VAR PROGRAM_NAME,PARAMETER_STRING):INTEGER
arguments   struc                   ; Template to arguments.
save_bp     dw      ?               ; Saved BP register.
ret_adr     dw      ?               ; Return address (near call).
;-------------------------------------------------------------
param_str   dd      ?               ; DWORD pointer to param. string
prog_name   dd      ?               ; DWORD pointer to ASCIIZ
                                    ; program name.
;-------------------------------------------------------(8 bytes)
arguments   ends

dos4BH      proc    near
            jmp     short exec_code
;------------------------- LOAD CONTROL BLOCK ----------------
lcb_envir   dw      0               ; Segment address of environment
lcp_ps_o    dw      ?               ; Offset of parameter string.
lcb_ps_s    dw      ?               ; Segment of parameter string.
lcb_fcb1    dd      0               ; Dword pointer to FCB1
                                    ; (5CH in PSP).
lcb_fcb2    dd      0               ; Dword pointer to FCB2
                                    ; (6CH in PSP).
;---------------------------- LOCAL VARIABLES ------------------
ss_save     dw      ?               ; Saved stack segment.
sp_save     dw      ?               ; Saved stack pointer.
;-------------------------------------------------------------
exec_code:  push    bp
            mov     bp,sp           ; Establish access to arguments.
```


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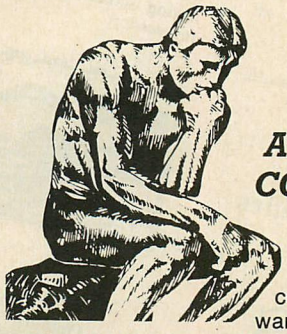
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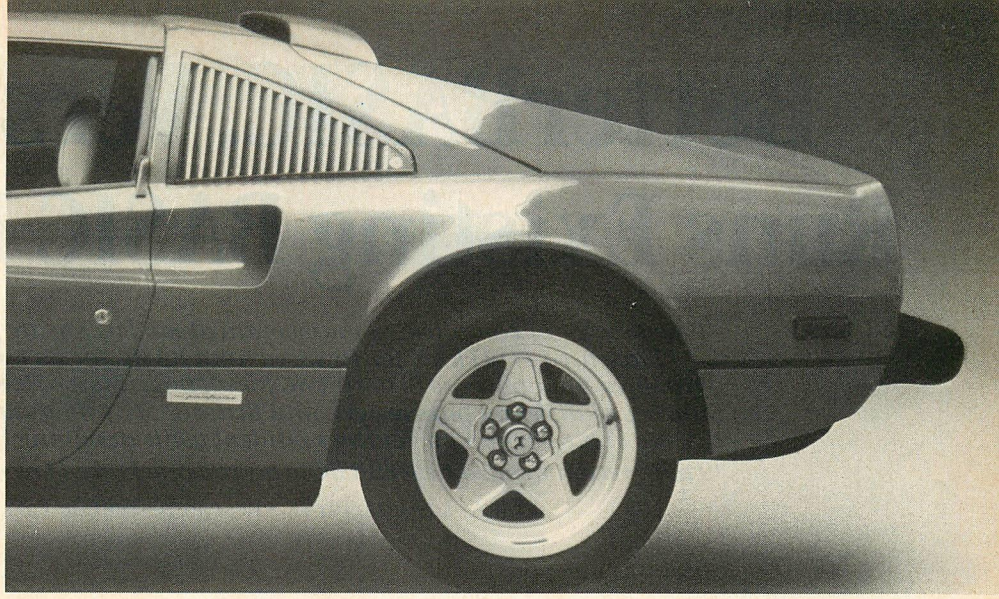
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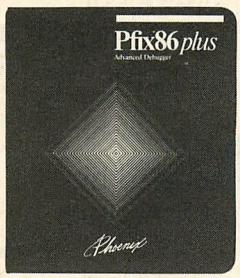
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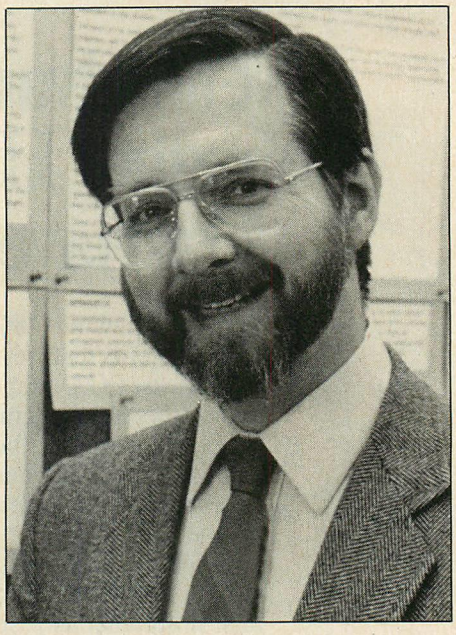
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```
            push    ds              ; Save the Turbo data segment.
            call    relo1           ; Set BX to relocation
                                    ; factor: true offset ...
relo1:      pop     bx              ; of reloc1 minus local offset.
            sub     bx,offset relo1

            les     di,[bp].param_str  ; Get offset:segment
                                       ; of parameter string.
            mov     ax,es
            mov     cs:lcb_ps_s[bx],ax ; Save parameter
                                       ; string segment ...
            mov     cs:lcp_ps_o[bx],di ; ... and offset in LCB.
            mov     ax,ss           ; Save SS and SP registers
            mov     cs:ss_save[bx],ax
            mov     ax,sp
            mov     cs:sp_save[bx],ax
            push    cs              ; Set up ES:BX as pointer
                                    ; to the LCB ...
            pop     es
            add     bx,offset lcb_envir
            lds     dx,[bp].prog_name  ; and DS:DX as pointer
                                       ; to the ASCIIZ ...
            inc     dx              ; ... program name.
            mov     ax,4B00h      ; DOS EXEC function: al=0, ah=4Bh
            int     21h             ; Let her rip.

            sti           ; Disable interrupts while stack messed up
            jc      run_error       ; Successful execution?
            xor     al,al           ; Yes, set error code=0.
run_error:  xor     ah,ah
            call    relo2      ; Recalculate relocation factor ...
relo2:      pop     bx
            sub     bx,offset relo2
            mov     dx,cs:ss_save[bx]  ; ... and restore the stack.
            mov     ss,dx
            mov     dx,cs:sp_save[bx]
            mov     sp,dx
            cli                ; Interrupts back on ... all done!

            pop     ds
            pop     bp
            ret     10          ; Pop arguments & "function result"
dos4BH      endp
code        ends
            end
```

LISTING 4: DOSCOM.PAS

```
program doscom;          { EXECUTE DOS COMMANDS }

{$I spmmlib.pas}         { INCLUDE SUB-PROCESSES & MEMORY MANAGEMENT }

var
   parameter_string,program_name:asciiz;
   memory_segment,pp_to_release :integer;
begin
pp_to_release:=$6A5;           { PLENTY FOR DOS 3.1 }
if dos48H(pp_to_release,memory_segment)=0 then
   begin                       { SEE IF ENOUGH MEMORY FREE }
   if dos_error_check(dos49H(memory_segment)) then
      exit;
   end
else  { IF NOT, THEN REDUCE THE SIZE OF THE CURRENT ALLOCATION }
   if dos_error_check(dos4AH(pp_to_release)) then
      exit;
if get_comspec(program_name) then
   exit;                  { TERMINATE IF CANT GET COMSPEC NAME }
while true do
   begin
   writeln;write('Enter DOS Command: ');
   readln(parameter_string);
         { BUILD THE PARAMETER STRING FOR COMMMAND.COM }
   if (parameter_string='bye') or (parameter_string='BYE') then
      exit;
   parameter_string:='/c '+parameter_string;
   parameter_string[length(parameter_string)+1]:=#13;
   if dos_error_check(dos4BH(program_name,parameter_string)) then
      writeln('Command Cancelled.')
   end;
end.
```


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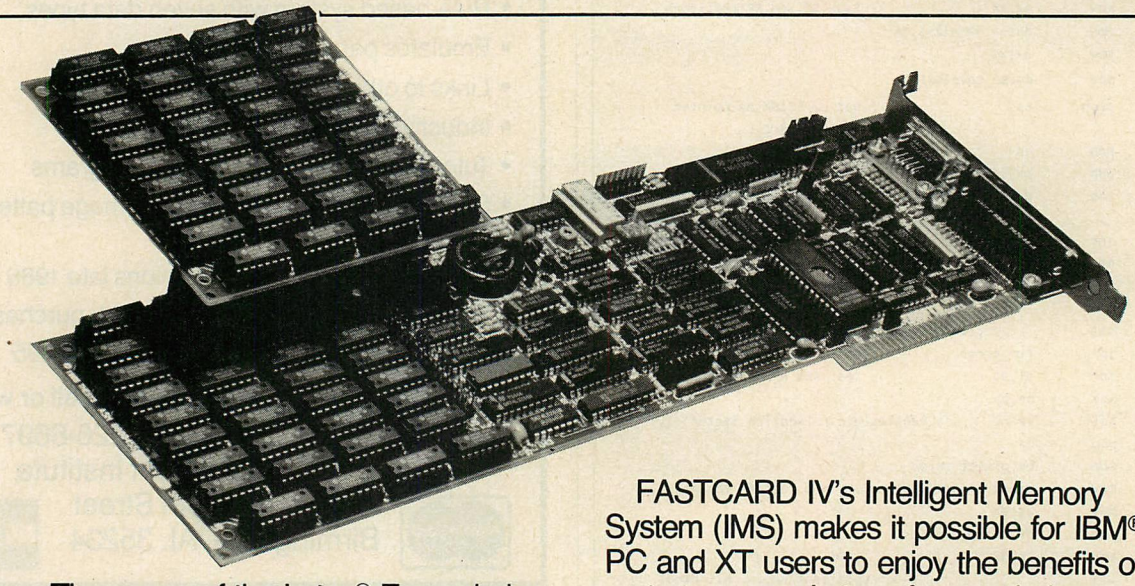
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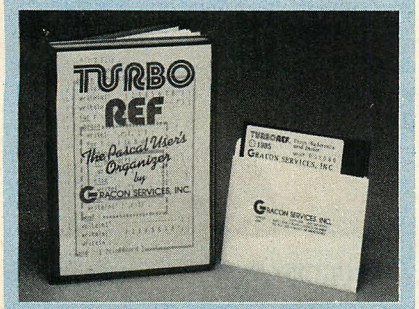


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Gracon Services bills TurboRef as "The Pascal User's Organizer." It essentially performs two tasks: printing source code and cross-referencing variables. It also can process multiple source files. A user's manual and full Turbo Pascal source code are included.

TurboRef has a mania for options. The user controls formatting details as well as options such as the case sensitivity of the cross referencer. TurboRef can analyze code for other Pascal compilers. Options are normally set with key words in an option file, but TurboRef can be made to prompt for option settings at runtime or even read them from DOS environment strings. The name of the option file can be entered on the command line when TurboRef is executed. The program's myriad options and flexibility in reading them are its most powerful aspects. What it actually accomplishes is less impressive.

The source lister is not capable of reformatting Pascal code. The main purpose of the listing is to number every line. Line numbers are important because the cross referencer's output is merely a list of identifiers and the line numbers on which they occur.

TurboRef's manual lists six major capabilities of the lister: drawing boxes around BEGIN-END blocks, highlighting reserved words, highlighting comments, underlining procedure declarations, listing the current procedure on every line, and listing the source file name on every line. Box drawing is the most aesthetically pleasing trick, although it does not necessarily improve programmer productivity. TurboRef's other features are more clearly useless.

The X-REF table does not list the procedure name of the reference and does not separate global and local variables. For example, if the variable *i* is declared locally in three procedures, all the line numbers where *i* occurs are listed together. No indication of dependency or effects of procedures is given.

TurboRef's output is designed for the printer, not the screen. It supports only four printers (the IBM Matrix, IBM Graphics, Epson FX+, and TI 850/855) and provides no convenient way for users to adapt the program for other printers. On the Brother printer used in this review, the results were slightly to thoroughly garbled. The Epson format is acceptable for screen viewing, but is far from perfect.

Numerous other features have quirks: the manual states that the optimal page width is 132 columns, but later says results are "unpredictable" if the form width is not 8.5 inches. Instead of putting the option file name on the TurboRef command line, the user may assign it to a DOS environment string. The manual says the string is XREFOPT, but this does not work. The correct string is TURBOREFOPT.

The cross-reference table tries to put *v*, *c*, or *t* next to a line number if the reference occurred in the VAR, CONST, or TYPE sections of a procedure. However, the proper letters are occasionally missing.

Box drawing is confused by any line, such as a label, that extends to the left of a block. Comments do not affect the placement of boxes, but they do interrupt box lines.

TurboRef handles include files curiously. It places them in the program listing, but does not reset their line numbers. The X-REF table restarts the line count at the beginning of every include file. Thus, X-REF line numbers cannot be related easily to listings.

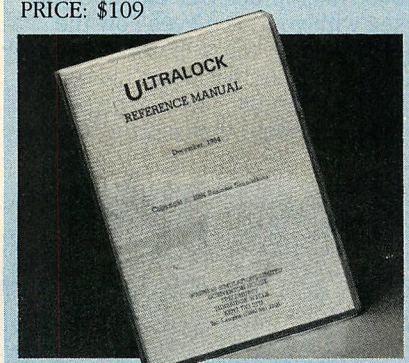
TurboRef processes two to six source lines per second, depending on program size. A 1,000-line program requires about three minutes to complete. The documentation is brief, but not inappropriately so—the program does not do very much.

—CHARLES BRADFORD

ULTRALOCK

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CIRCLE 351 ON READER SERVICE CARD

Ultralock is a RAM-resident encryption program that operates transparently so only encrypted files are allowed on disk. When a file is loaded into a program it is put into unencrypted form; when saved to disk it is

encrypted. Ultralock intercepts each DOS function call for disk reading or writing and encrypts or decrypts as needed. Separate encryption keys can be specified at the beginning of a session for each file or group of files, or this information can be supplied by a key list file for which an encryption key is necessary. Not all files in a directory need be protected.

Once Ultralock is loaded the user can forget about it—no need to recall whether the most recent version of a file has been properly encrypted. The programs can be copied, but the master disk must be in drive A: or B: for the initial load. The time required for reading and writing increases by 20 percent due to the decryption and encryption. Ultralock requires at least DOS 2.0 and seems compatible with a wide variety of other RAM-resident programs.

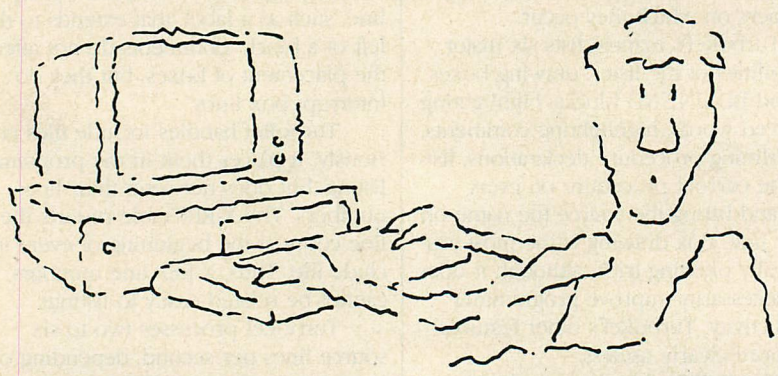
Despite its good user interface and clear documentation, Ultralock has some deficiencies. First, the encryption algorithm is proprietary so the user has little idea of how secure his files really are. Second, although disk files are always encrypted, main memory is not purged when exiting a program. Someone using DEBUG could scavenge main memory and retrieve the sensitive file.

The program's inability to distinguish between ciphertext and plaintext can lead to the following scenario. A key is specified for a file in a particular directory. Inside the editor the user writes out the current file to a different disk or directory. Unless protection on the different disk or directory was previously specified, this file will be written in cleartext. A file backed up to a different disk will be in cleartext.

Ultralock currently does not work with DOS 3.1. Business Simulations, Ltd. said that it will update the program when the European market increases its use of networking. The company has no plans to have customer support available directly from the United States.

Ultralock provides advantages for an environment in which many users share the same hard disk for sensitive data. If transparency is an important factor, Ultralock has no competitor.

—VICTOR MANSFIELD



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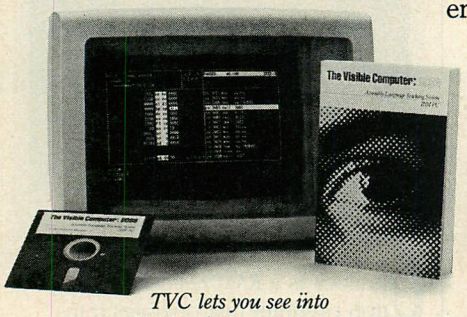
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Major Software's Debugging Duo is uneven in its quality. The company has been selling Tidy, a Pascal formatter, for more than a year, but has made few changes since the version reviewed in "The Well-Formatted Pascal" (Steven Armbrust and Ted Forgeron, *PC Tech Journal*, October 1984, p. 22).

Tidy is still fast, dependable, and useful. It takes any error-free Turbo Pascal source file and produces properly

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indented code with well-placed comments and capitalized reserved words. Version 4.9 differs from earlier versions in that it provides runtime options for generating output with numbered lines and/or 132 columns.

The second and newer partner in the Debugging Duo is PascalPac. Major Software says PascalPac is intended to be used with Tidy, but the products do not seem to depend on each other or communicate with each other in any way. Their manuals are similarly bound in thin cardboard-backed pamphlets; Tidy's manual shows signs of having been proofread, while PascalPac's manual is full of garbled sentences.

PascalPac actually consists of four utilities. X-REF is an unusually lame cross referencer. It reads a source file and lists in alphabetic order all the identifiers the file contains. Next to each identifier, X-REF lists all line numbers on which that identifier appears.

And that's it. X-REF does not handle include files and does not provide any information about interprocedural dependencies. It makes no attempt to distinguish between global and local variables of the same name, or between lines on which a variable's value might change and those on which it is merely referenced. X-REF provides only an index, by line numbers, of all the identifiers in one source file.

X-RAY uses the output of X-REF to find identifiers and display them in the context of surrounding lines. It splits the screen horizontally and uses the top half to display the source file and the bottom half to display the output of X-REF. X-RAY is similar to a read-only editor that uses X-REF's output to speed up its search function.

X-PRNT is an unremarkable program for printing text files. It can paginate a listing, number lines, print time- and date-stamped headings, or halt while the user inserts paper in a printer with no tractor-feed mechanism.

X-PEEK is a version of X-RAY that does not use the output of X-REF. It loads a text file and lets the user page or scroll through it forward and backward. X-PEEK, like X-RAY, is command-oriented. The cursor remains on a command line at the bottom of the screen at all times. To move the display one line up the user types UP (or presses the up arrow) and presses Enter.

X-PEEK could be useful if it were smaller and a bit more powerful. Most programmers could use a small read-only editor that loads quickly, handles big files, provides reasonable string-search and spot-marking facilities, and allows rapid movement through the file.

X-PEEK is not it. X-PEEK.EXE is 46,040 bytes long; several real editors, such as IBM's Personal Editor and QuickSoft's PC-Write (a "shareware" program), are about the same size or smaller. X-PEEK will not load a file larger than 32KB. It also does not use the BIOS scrolling routines to move the screen display. It writes screens quickly, but to scroll up or down a single line, it rewrites the entire screen and causes an annoying flash. It provides no functions beyond simple page- or line-oriented movement through a file.

Although Major Software does not consider X-PEEK to be the lead utility in PascalPac, it might eventually be useful. The rest of PascalPac offers the user little more than an editor with a fast string-search function.

Tidy, on the other hand, is quite nice. It makes Pascal easier to read and understand, and thus serves more than a cosmetic function. Even if its function were only cosmetic, it would serve a useful purpose. Programmers have enough to do without worrying about stylistic niceties.

—COLE BRECHEEN

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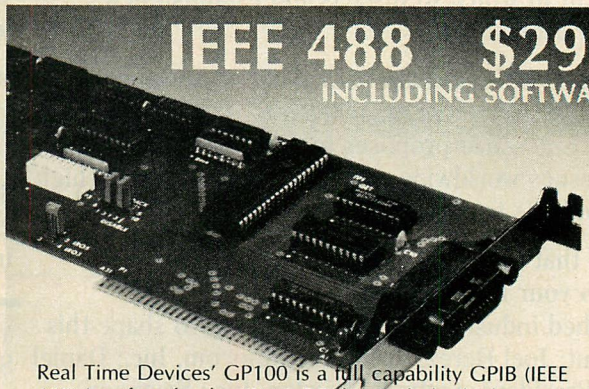
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Navigating through the subdirectories of a packed hard disk is not an easy task. A user often needs to browse through the current directory while using an application, glance at the contents of a file, or start searching for a group of files with little to go on.

WindowDOS is one small, quick, and usable contender among memory-resident DOS extensions that are used to tame this hard-disk complexity. It is a full-screen DOS interface that makes good use of foreground and background colors, the function keys, and the numerics pad. Its memory-resident form provides expanded DOS commands with hot-key convenience; a user typing away in a word processor can simply press the Ctrl-Ins combination to examine directories, delete files, and change the default directory, then return to the application by pressing the Esc key. A prompt line option tells WindowDOS whether to stay resident after Esc or release its memory to DOS. WindowDOS can run on a monochrome, color, enhanced color, or professional graphics monitor and can work with hard, floppy, and RAM disks.

WindowDOS screens are generally clean and readable; they show file names and provide more detail only if it is requested by the user. The basic screen is a 17-by-5 table of the files and subdirectories in the current directory. Files are selected by moving the cursor to the file name using the cursor-control keys, a great improvement over typing file names. WindowDOS has no mouse interface, but it is hardly needed with all eight cursor-control keys available. If the entry is a file, its attributes and size are displayed on the upper left of the screen. A single keystroke lists the file in hex or ASCII format. If the entry is a directory, pressing the Enter key updates the table to the new directory. A prompt line along the bottom of the screen lists standard DOS functions; the user can access more specialized functions through function keys and pop-up menus.

Used in combination, these functions let the user flip through directories with ease, examining, reorganizing, copying, or deleting along the way. This housekeeping can be done in several different styles. Pop-up menus provide a search command equivalent to WHERE.COM (see "A Good Find," Mark S. Ackerman, *PC Tech Journal*, October 1985, p. 85) and a subdirectory diagram equivalent to DOS's TREE. But a user would turn to these exhaustive disk-bound techniques only as a last resort; WindowDOS encourages a more interactive method. Cursor key selections from directory tables simplify the task of paging through directories by mov-

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ing up or down the directory tree. A default file spec option further focuses the search; when set to **t*.***, for example, it displays only those file and directory names that start with the letter *t*. Another nice feature is use of the Tab key, which cancels a command line the way Esc does in DOS.

WindowDOS augments DOS's ability to process groups of files with a single command. When wild-card specifiers are inconvenient, the user can select and mark files on a screen for collective copying or deleting. WindowDOS's PURGE command allows another style of deleting; it displays specified files one by one and prompts for deletion. The SORT command organizes directories by size, creation date, name, or extension.

Other enhancements include the RENAME command, which can be used to move files from one directory to another without actually copying them. The directory entries are changed but the files remain in their old physical location. Other commands are mapped onto the function keys and accessed with pop-up menus.

Although some WindowDOS commands are powerful, they are inconvenient to use. In updating a directory, for example, WindowDOS forces the user to type in the entire path name for the new directory. Users of huge directories will encounter yet another WindowDOS limitation. It can display only three screens of files (255 entries) and ignores the rest.

WindowDOS is a useful product as it stands, but a few patches and enhancements could make the next version much better. It has a command to create a directory, but not to delete a directory; furthermore, it has no provision to rename a directory or volume. WindowDOS would take on some debugging ability if it were able to modify files or display an area of memory. Another useful feature would be an expanded type-ahead buffer.

Overall, WindowDOS is a well-designed and useful product. The manual is short and worth reading. The sparse on-line help is adequate because most screens are self-explanatory. WindowDOS is perfectly usable in non-resident mode but its 40KB resident size should not strain a system's resources. It does not take up much memory for the functions it offers; Borland's SideKick, for example, is 20KB bigger and the DOS enhancer XTREE is more than three times as big.

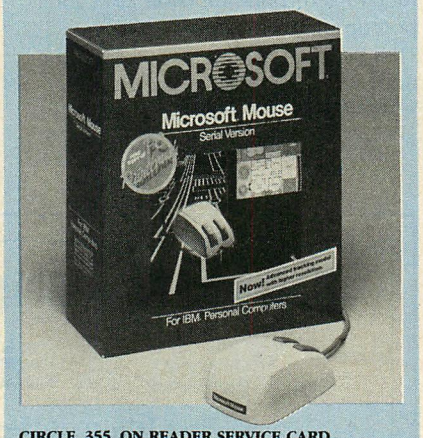
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Microsoft's Mouse was not the first generally available mouse for the PC, but with Microsoft's influence, it set the standard for mouse software interface (see "A Tale of Two Mice," Jeff Duntemann, *PC Tech Journal*, April 1984, p. 150). Microsoft has updated the Mouse software several times since its release in November 1983; now the hardware has been redesigned—in time for the long-awaited release of its software destiny, Microsoft Windows.

The most apparent difference is one of ergonomics. The new mouse casing fits the hand much better than did the original mouse. The button actuators now wrap around from the top surface of the mouse toward the front, accommodating several different grips and button-pressing styles.

The second revelation comes in pushing the Mouse around the tabletop. The original Mouse rode on a large satin-finish steel ball in a loose cage and four steel ball bearings in tight races. All that metal generated an annoying clatter when moved rapidly. The new Mouse scoots about smoothly on Teflon slides, its position-sensing ball coated with soft plastic, à la Macintosh.

The original Mouse cable connector did not have lock-down screws to mate with standard D-style connectors and, consequently, came unplugged at the least provocation. The redesigned cables can be locked into their D-connectors with thumb nuts.

Microsoft recognized that the main position-sensor ball in a mechanical mouse gets dirty. The old mouse required a screwdriver to get at the ball cage for cleaning. The new mouse has a snap-in, snap-out ball retainer.

All these changes are absolutely on-target, and the new Mouse appeared at first glance to be about as good as any mechanical mouse is likely to get; however, one race around the table uncovered an agonizing, crippling flaw: the two actuator buttons, while placed perfectly, do not click. Upon pressing, the new Mouse buttons simply descend and bottom out, with the dullest hint of a click at the very bottom.

Clicking provides positive feedback that a selection has been made. Without a solid, snappy click from the mouse switch, the user must watch the screen to see if the desired selection took place. This erodes confidence in the channel of communication between mouse and machine and distracts from the job at hand. The new Mouse is less pleasant to use because of its buttons, irrespective of all the other excellent improvements in the mechanics.

The motion-sensing mechanism now has a resolution of 200 points per inch (the original Mouse resolved 100 ppi), reducing by half the disk area required to move the pointer through an entire graphics screen.

The Mouse driver software interface has two new function calls. Call 16 hides the Mouse pointer conditionally, if the pointer enters a predefined area. Call 19 (calls 17 and 18 do not exist) defines a threshold speed value (given as mickeys/second) past which the apparent speed of the pointer across the screen doubles. This features allows the user to move the pointer from one end of the screen to another very quickly.

PC Paintbrush, Z-Soft's paint program that Microsoft bundles with the Mouse, has been greatly improved in terms of speed and features. The updated program can rotate rectangular regions of the screen and generate spline curves. In addition, the screen-print utility, Frieze, supports many more printers and is considerably easier to use than earlier releases.

Release 5.0 of the Microsoft Mouse and supporting software is hair-tearingly schizophrenic. What began as a masterful redesign of an industry classic was ruined by the use of cheap switches on the internal logic board. Microsoft has the power to find better switches if people demand them. Until then, however, take this Mouse for a test drive before buying it.

—JEFF DUNTEMANN

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CIRCLE NO. 102 ON READER SERVICE CARD

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License to Sell

The software license agreement, although widely accepted by users, is not always the clear-cut decision for publishers that it seems to be.

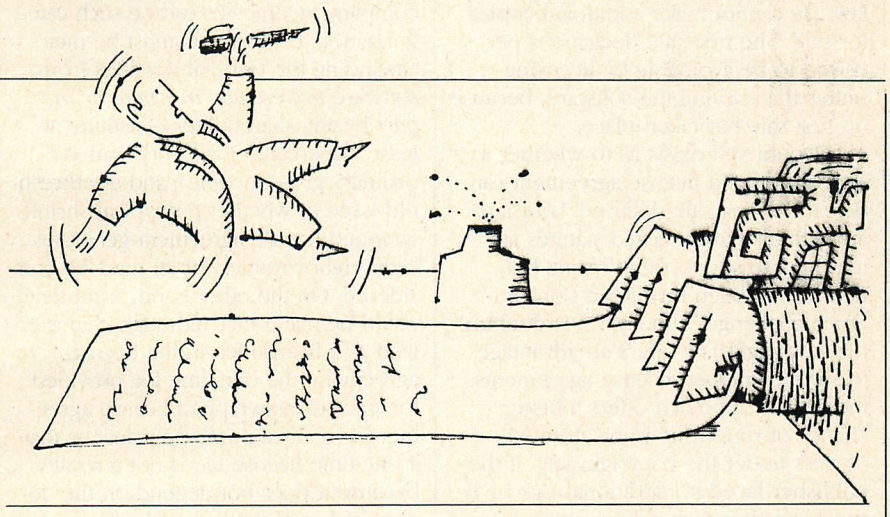


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The first Legal Brief ("The IBM Software License," July/August 1983, p.149) examined the IBM license agreement and pointed out provisions that should have caused customers to resist if not rebel. It now has to be conceded that the license agreement technique is by far the most common form of transfer of rights in computer software.

With the benefit of nearly three years' hindsight, license agreements deserve another look, this time with an emphasis on how a publisher might evaluate the pros and cons, vis-a-vis as agreements for the sale of software. To compare apples with apples, assume that the publisher has the choice of either a written license agreement or a written sales agreement.

In general, software license agreements have the following goals:

- They seek to limit warranties.
- They seek to limit the liability of the publisher.
- They seek to apply the law of one particular state to the interpretation and enforcement of the license.
- They seek to control dissemination (and copying) of the software.

Surprisingly, few software license agreements attempt to accomplish what license agreements traditionally do: set a limited term of use and provide for periodic fees for continued use. Given that the publisher is willing to grant perpetual use of his software in return for a one-time fee, is there any advantage to his using the license mechanism rather than a sale?

The first objective (restricting warranties) certainly can be accomplished in the context of a sale. Certain requirements must be met if a manufacturer wishes to claim that his product carries a full warranty, but if he chooses instead to give a limited warranty, he has wide latitude in setting its terms. He can, if he chooses, sell his product "as is," with no warranty. To create a limited warranty, he must comply with certain requirements as to form, but these requirements also apply if the product is licensed rather than sold. No advantage is apparent to a perpetual license agreement over a sale from the viewpoint of limiting warranties.

The second objective of limiting the amount of liability overlaps with the first. It comes into play in the case of a breach of warranty or if the licensor violates the license agreement in some other way (admittedly, an unlikely event). In that case, even though the licensee is entitled to compensation, the amount of the compensation is limited to some specified amount.

Suppose a license agreement warrants that the software will conform to the specifications in the manual, and the manual says that the software will calculate payroll deductions and subtract them from gross pay to arrive at net pay if the specified steps are followed. Further, suppose the license contains a limitation of remedy provision, which provides that in the event of a defect the licensor will replace the software or refund the purchase price (here, say $100) at licensor's option; all incidental, consequential, and special damages are disclaimed. The software calculates payroll deductions, but it adds them to rather than subtracts them from gross pay. The licensee clearly wins his breach of warranty claim, but all he gets (if the limitation of remedy provision is enforceable) is $100, regardless of the loss he has incurred. This, however, is not unique to the licensing approach; a similar provision in a sales contract would face the same issues as to enforceability and, if it survived, would lead to the same result.

While broad similarities exist among the various states' laws, significant differences also are present in statutory provisions and in the development of case law. A Maryland company has a legitimate interest in uniformity of interpretation of its contracts regardless of where the other party to the contract is located. This interest in uniformity can be advanced by providing in the contract that it will be interpreted and enforced according to Maryland law. Generally, a company can select the law of its state of incorporation or a state where it has substantial business contacts. The enforceability of a choice-of-law provision would be more doubtful if the state were chosen because it had favorable provisions in its law.

The final common objective is to limit copying of the software. Federal copyright law prohibits copying (whether a license or a sale is involved) unless it falls within a recognized exception, such as fair use, copying as an essential

step in utilization, and archival copying. Some publishers wish to restrict the right to such noninfringing uses as well. They do not want the customer to lend or rent his copy of the software. Under the *first sale doctrine*, the owner of a copy of a copyrighted work could do so: once the copyright holder has made a sale of a copy of the work, the new owner may treat his copy as his property and resell it or make any other use of it not in violation of the copyright law. He cannot make additional copies for sale. The first sale doctrine is perceived to be avoidable by licensing rather than selling the software, because no first sale has taken place.

Doubt still exists as to whether a shrink-wrapped license agreement can defeat the first sale doctrine. Louisiana and Illinois have enacted statutes attempting to support that result, but neither has been through a Constitutional challenge. Although it is doubtful that copyright law offers an advantage to shrink-wrapped license agreements, the license approach offers a better chance of restricting rights granted owners under the copyright law. If the publisher faced no additional risk by licensing rather than selling, this advantage might justify a decision to use the licensing technique.

Section 541 of the Internal Revenue Code provides for special taxation of a *personal holding company*: a company that is a corporation, with more than 50 percent of the value of its outstanding stock owned by no more than five individuals, and 60 percent of its "adjusted ordinary gross income" is "personal holding company income," which includes royalties and rents. Provisions for copyright royalties take them out of the category of personal holding company income. To escape such categorization, certain tests must be met (including the test that royalties from software *not created in whole or in part* by any shareholder constitute at least 50 percent of the corporation's ordinary gross income), and the threshold issue of whether the typical shrink-wrapped license agreement generates "copyright royalties" at all must be considered. On the other hand, arguments could be made that, although characterized as a license fee in the license agreement, the one-time fee provided for in a shrink-wrapped license agreement is really a purchase price, or that a one-time license fee is not a royalty because it does not depend on the degree of use of the licensed software.

Choosing to license software presents the risk that the publisher is receiving personal holding company income that could be subject to the provisions of Section 541 et seq. If the software is sold, the problem is avoided.

Currently a 50-percent tax is levied on undistributed personal holding company income. The tax can be avoided by distributing the income but (assuming it is distributed to stockholders as a dividend) the stockholders then will be subject to a tax on the dividend. If the company needs to retain the income at the corporate level to finance product development, the choice of the license mechanism may prove costly.

The impact of the tax risk on a company's decision to license or sell can be evaluated only on a case-by-case basis. IBM presumably did so and concluded that it had no risk of being deemed a personal holding company. In that context, even if the potential benefit of opting for licensing is very small, the risk is even smaller so the choice to license is not difficult. For many software companies, the choice is not so clear-cut; the potential tax costs may outweigh the potential copy restriction benefits.

Max Stul Oppenheimer, PC, is a partner in the law firm of Venable, Baetjer & Howard, located in Baltimore, Maryland.

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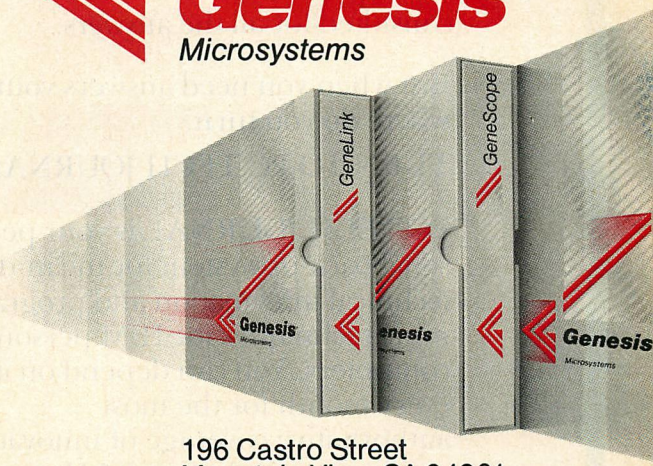
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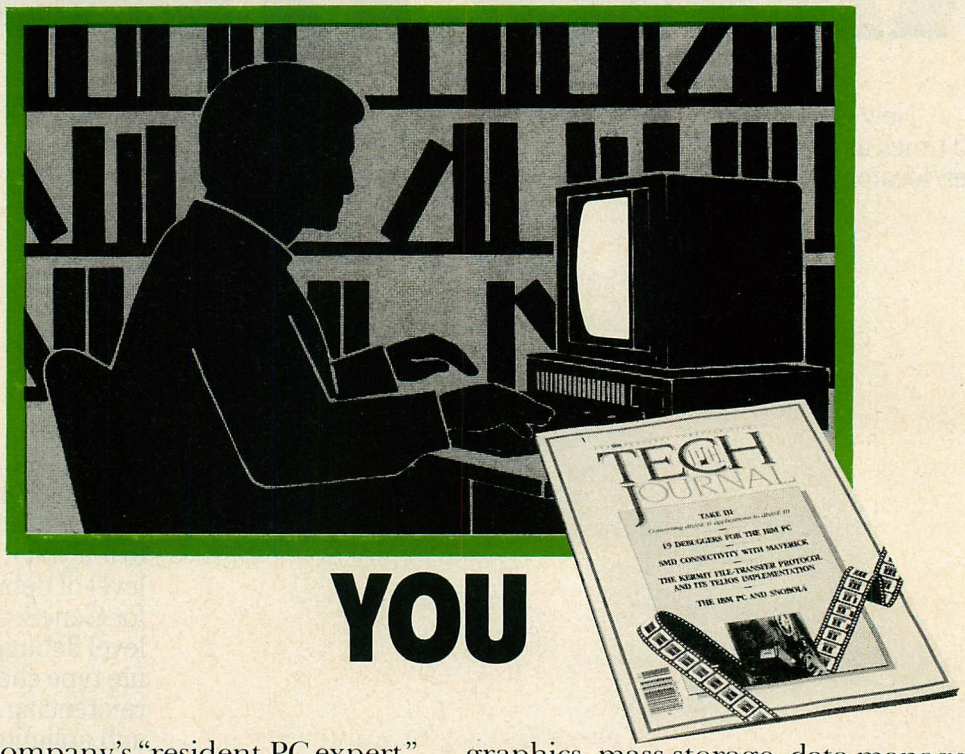


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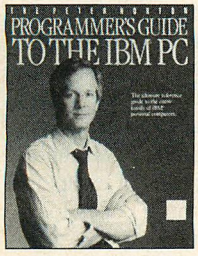
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4Z312

Keeping the Family Straight

In his latest book Peter Norton outlines the technical distinctions among members of the IBM PC family; the book does, however, have a few shortcomings.

Programmer's Guide to the IBM PC
Peter Norton (Microsoft Press, Bellevue WA 1985) 426 pages, paper, $19.95



Peter Norton is widely recognized as a primary authority on the IBM PC. His well-known Norton Utilities, which deal intimately with the inner workings of the machine, demonstrate that this recognition is well deserved. Thus, a new book by this author is worthy of note.

The intended audience for the *Programmer's Guide* is just that: programmers who are somewhat familiar with the system but want to learn more in order to write better programs. Norton says he set out to write both a reading book and a reference book; he has succeeded fairly well in both regards.

A major feature of this book is the pointing out of differences between various models in the PC family: the plain vanilla PC, the PC/XT, the Portable PC, the PC*jr*, and the PC/AT. Unfortunately, coverage of the AT is somewhat less than complete, and the reader is often referred to the IBM documentation for some of the most significant and difficult details. This leaves the impression that the book was written before the author had fully explored this newest machine, and it detracts somewhat from the usefulness of the book. By contrast, the PC*jr* (a machine that is now out of production and thoroughly covered in two entire books by Norton) receives extensive coverage.

The first seven chapters cover the basic design of the various models as well as their peripherals: the microprocessors, support chips, keyboards, disk drives, video displays, sound generation (half of this chapter covers the PC*jr*) and assembly language. It is not, however, meant as an assembly language tutorial, and it provides just enough information to be dangerous, but not enough for a user to become proficient. Successively lower levels of controlling the system are described: built-in facilities of a high-level language, DOS functions, BIOS services, and direct hardware manipulation. Norton quite sensibly advises the reader to program at the highest level that provides the required level of control.

The major portion of the book, 11 chapters, describes the BIOS and DOS services available to programs through interrupts and function calls. This information is taken from IBM's hardware and DOS technical references, but it is presented in a much more readable format and with some advice on how and why to use each service. In addition, Norton describes some undocumented subtleties he has discovered through experience. However, because of several significant errors and omissions (more on these later), the *Programmer's Guide* cannot totally serve as a replacement for the original documentation. Although in many respects it delves deeper into certain subjects, it sometimes stops short of fully explaining a complicated concept. For example, the following is included in the discussion of the INT 22H terminate address vector: "This is exotic stuff. Don't mess with it if you don't understand it. If you are qualified to use this feature, then you probably understand it better than I can explain it."

The last two chapters deal with programming, specifically with interfacing assembly language routines to high-level languages. They describe the kind of information about linkage conventions and data formats that must be available to implement such interfaces. Three examples are provided: BASIC (both interpreted and compiled, with emphasis on the latter), Lattice C, and IBM/Microsoft Pascal. The information here largely duplicates information in the respective compiler manuals, but, again, is presented in a much more digestible manner than in the compiler documentation (especially for BASIC).

As mentioned previously, some information included in the book is wrong or incomplete. Readers new to assembly language will be led astray by two errors. First, it is stated that any of the registers AX, BX, CX, and DX may hold an offset address. One program example even contains the instruction MOV AX,[DX] which is patently illegal and will not assemble; only the registers BX, BP, SI, and DI may be used to hold an offset for addressing memory. Second, diagrams that are included to illustrate the use of the stack indicate erroneously that the SP register points to the location into which the next push will occur, instead of the location of the last item pushed.

The description of DOS functions 11H and 12H (find first and next matching files) is wrong. The book implies that the output of these functions (the name of a file that matches a search pattern) is placed into the same file control block (FCB) that contains the search pattern, whereas in fact these functions construct a new FCB at the current DTA (disk transfer address). But information for functions 4EH and 4FH, which perform the equivalent services using path names, is correct.

As for omissions, no good description of the differences between .COM and .EXE files is included. In several places, the author implies that the program segment prefix (PSP) resides in the same segment as the code, without pointing out that this is true only for .COM, not .EXE files. It also is not generally true that files that are convertible from .COM to .EXE format are executable in either format, as the book claims, because in most cases, a program written as a .COM file will crash the system if run as a .EXE.

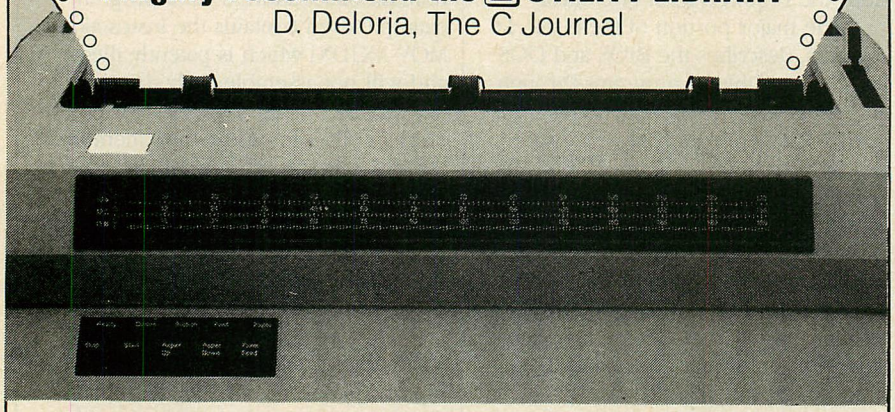
Finally, installable device drivers are mentioned briefly. The appendix devoted to them discusses the ANSI.SYS driver in very general terms. ANSI.SYS and device drivers in general are poorly documented in the DOS manuals, and better information is sorely needed. Perhaps in Mr. Norton's next book.

Despite the said errors and omissions, the *Programmer's Guide* is highly useful for anyone with more than a basic understanding of the PC. The advice on writing programs to run on a wide variety of configurations will be valued by authors of commercial software, and the additional information not available in official documentation is helpful to any user. The book is especially recommended to users with a low-intermediate level of experience who want to progress to high-intermediate. Unfortunately, the book cannot take the reader to the expert level, because it seems to withhold information just when a subject gets interesting.

—TED MIRECKI

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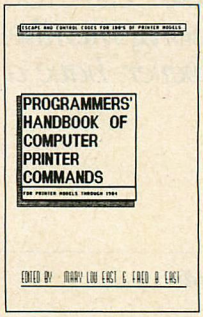
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Programmers' Handbook of Computer Printer Commands

Edited by Mary Lou East and Fred B. East (Cardinal Point Inc., Ellettsville, IN; 1985) 258 pages, spiral bound, $37.95



Those who remember the days before pocket calculators became available also remember books of mathematical and financial tables, filled with endless compilations of logarithms, sines, cosines, and loan repayment factors. Although the silicon revolution has relegated these publications to the scrap heap along with slide rules and carrier pigeons, it has made necessary another type of book of tabulations. The *Programmers' Handbook of Computer Printer Commands* is a prime example of such a volume. No light reading to be found here, just pages and pages of escape sequences and other control codes for more than 100 computer printers.

But don't throw away the printer manual just yet. This book is by no means a replacement (nor does it claim to be). Most printer manuals have a chapter or appendix listing just the control codes, with minimal explanation of how or why to use them. Such a concise summary is useful as a reference only after a user has become familiar with a printer through reading the detailed sections of the instruction manual and operating his printer over some period of time. This book merely reproduces these tables for a large number of printers. It does not provide sufficient information to write a printer driver for a totally unfamiliar printer, but does permit a comparison of differences among similar models. However, as will be explained, trying to use this book to determine which models are similar is not easy.

The title page claims that the book covers printer models through the end of 1984. This may be true, but it has some significant omissions. In the table of contents, several makes are listed with an accompanying notation that information for them was not received from the manufacturers in time for publication. Some of the well-known makes omitted for this reason are Atari, Canon, Data General, Inforunner, Smith Corona, Wang, and, yes, IBM. The book includes a mail-in card inside the front cover for registering each copy for

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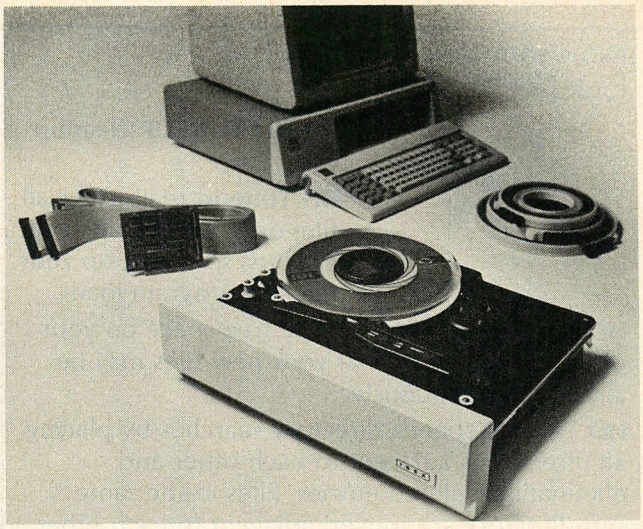
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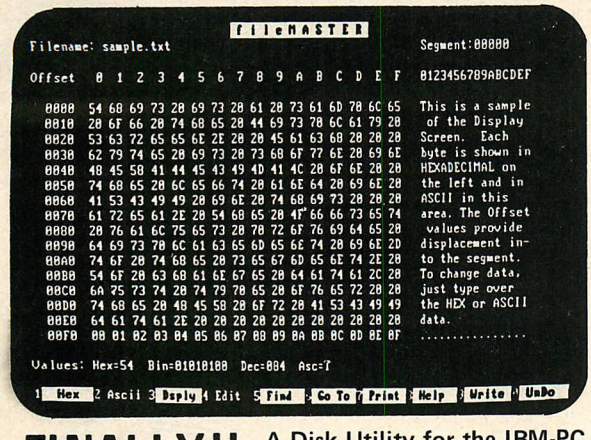
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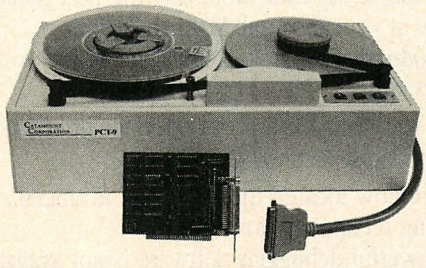
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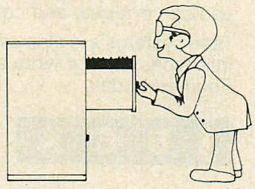
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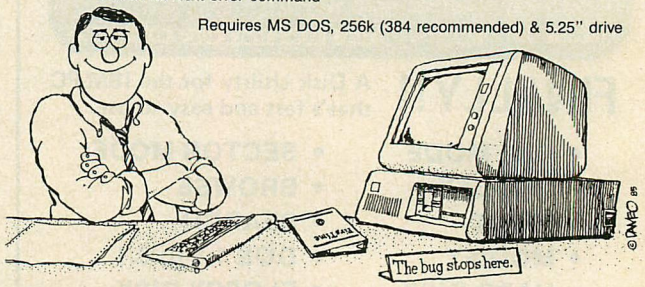
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error corrections and information regarding the availability of updates.

Another problem is that the information on the printers covered is not always as complete as it should be. Code sequences of the type **ESC X n** do not specify the format of the number *n*: whether it is binary, decimal, ASCII, etc. Some attempt is made to describe the format of these numbers used by Qume-compatible printers, but it is far from complete. For Hewlett-Packard printers, one table of codes is divided into the three levels of sophistication for basic print and space, data processing, and advanced document processing. This table is meant to cover all HP models, but no indication is given as to which models support which capabilities. Further, the Thinkjet's Epson-compatible mode is not even mentioned.

The aforementioned shortcomings are specific in nature; the book's most serious drawback is that it does not summarize or classify the mass of information contained in these tables. Even though standardization of printer codes has a long way to go, several large families of printers that use similar codes are recognized within the industry. Among dot-matrix printers, the Epson standard is preeminent (even IBM subscribes to it), while Qume and Diablo rule the daisy-wheel world. The classification of printers into these broad categories would greatly assist the user in integrating an unfamiliar printer into a system; as it is, any similarities must be deduced by careful perusal of the code tables. Other information that would concisely characterize the differences among printers is the minimum horizontal and vertical motion increments. If the printer manufacturer does not provide such information directly, it should be the editor's responsibility to ferret it out of the data provided.

Granted, the editors who take on the job of compiling this volume of information have a thankless task. When reading a how-to narrative, the reader remembers the good points from the text, but in using reference tables, he more likely will remember only the difficulties that he encountered when trying to locate the desired information. And in this reference, the difficulties are plenty. *The Programmers' Handbook of Computer Printer Commands* can be a serviceable aid to the user who needs to work with a variety of printers, but only if that user is already familiar with a good number of them.

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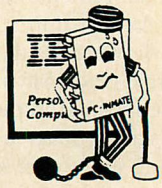
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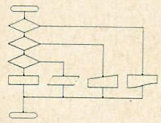
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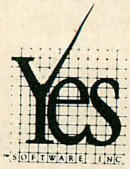
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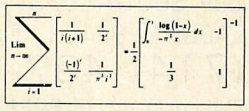
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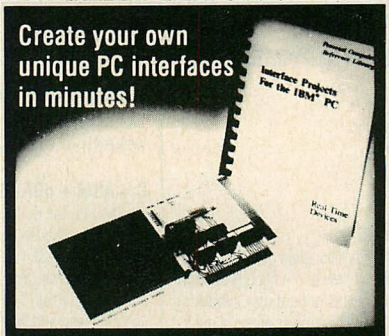
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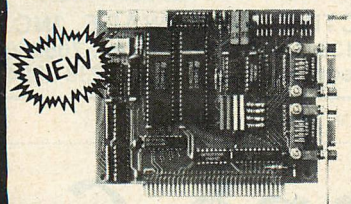
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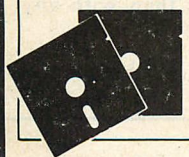
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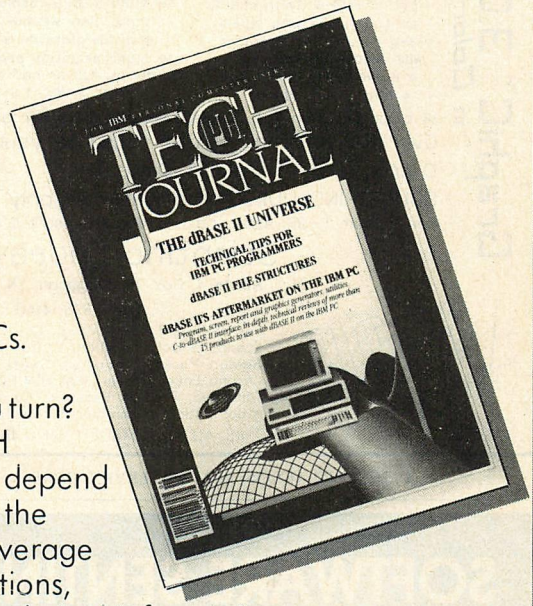
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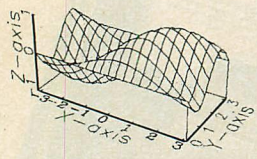
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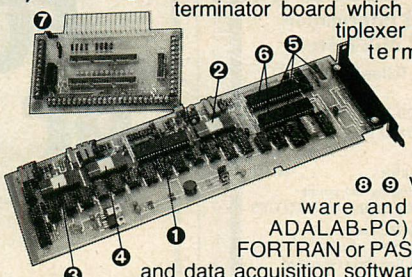


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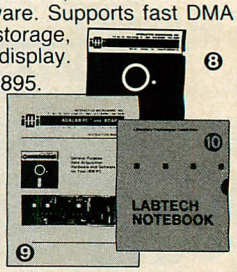
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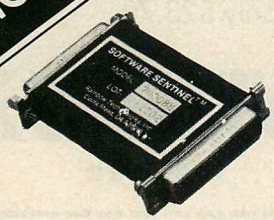
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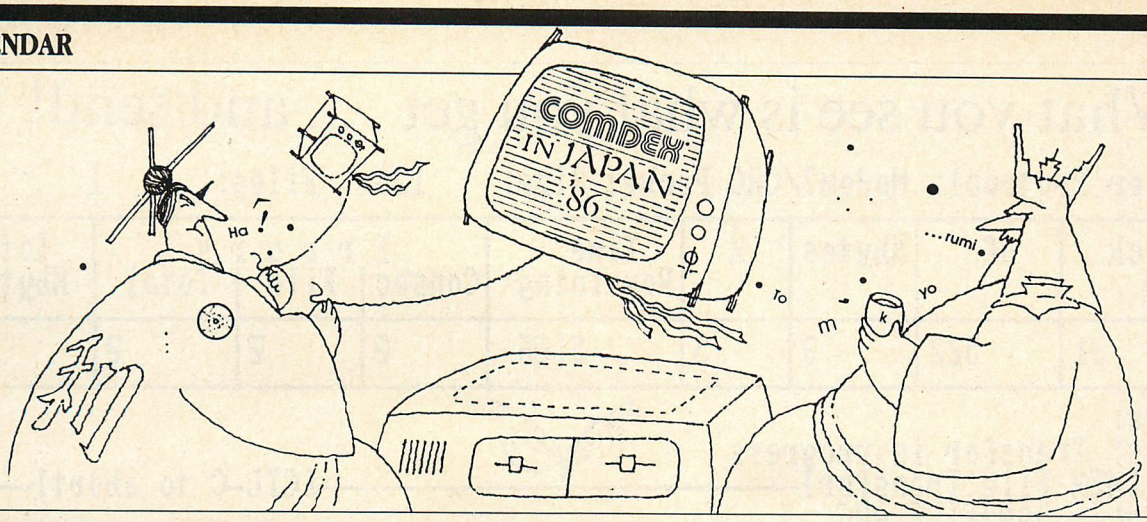


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Block #	of	Kbytes	%	Time Remaining	Errors Consec	File	Total	Total Kbytes
31	522	3	5	5:06	0	0	0	3

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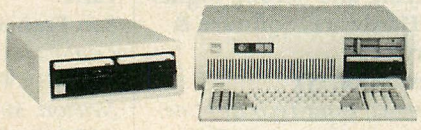
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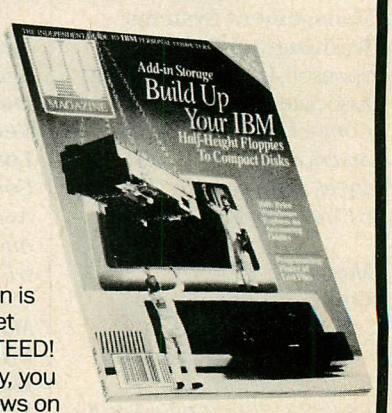
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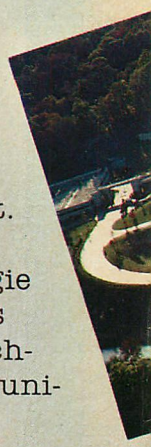


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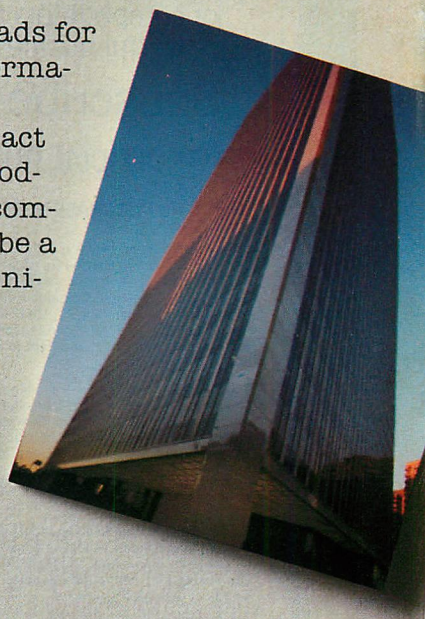
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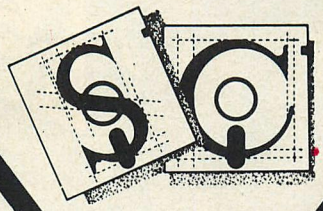
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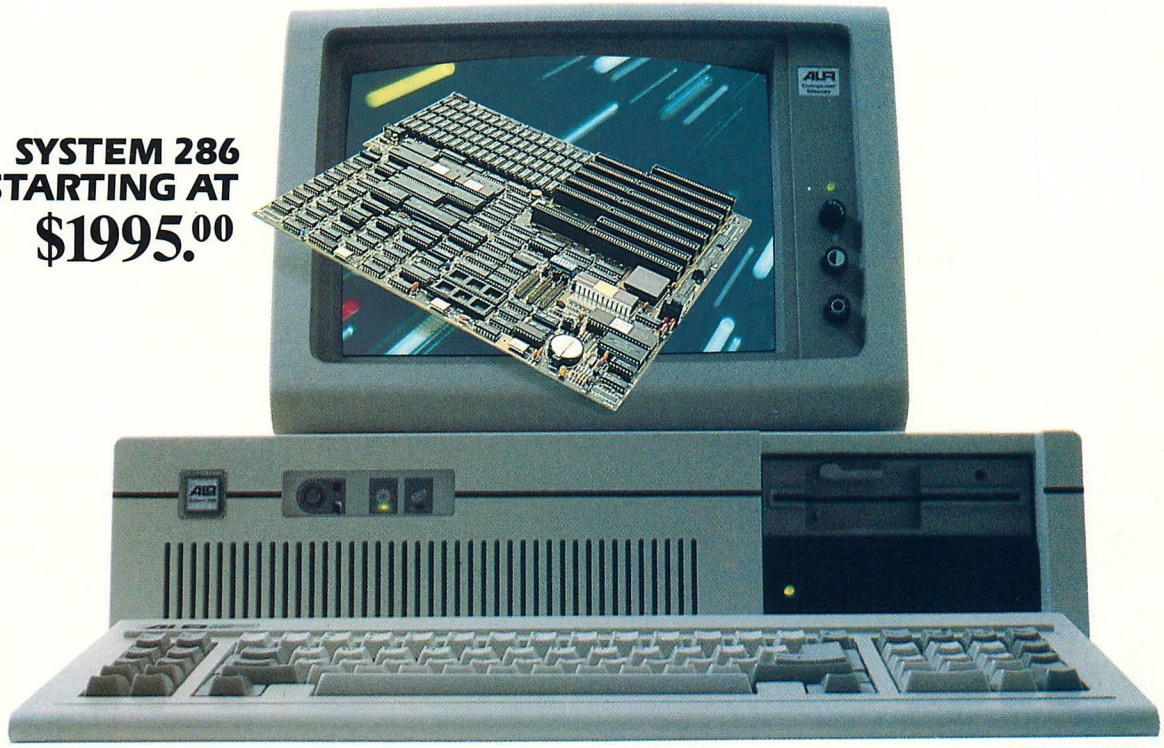
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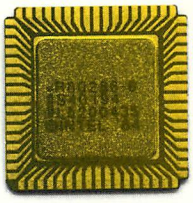
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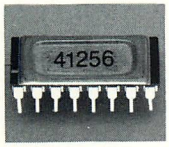


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